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Soil Survey

of

The Capistrano Area, California

By

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Bureau of Chemistry and Soils

In cooperation with the
University of California Agricultural Experiment Station

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SOIL SURVEY OF THE CAPISTRANO AREA, CALIFORNIA

By E. J. CARPENTER, United States Department of Agriculture, in Charge, and R. EARL STORIE, University of California

AREA SURVEYED

The Capistrano area is in southern California about halfway between Los Angeles and San Diego. It covers 418 square miles, or 267,520 acres, in the northwestern part of San Diego County and the southern part of Orange County (fig. 1). The Pacific Ocean forms the western boundary, and on the south and east as far as Fallbrook the area joins the previously surveyed Oceanside area.[1] The northeastern boundary is formed by the San Diego-Riverside County line. On the north the area joins the previously surveyed Anaheim area.[2]

FIGURE 1.—Sketch map showing location of the Capistrano area, California

Bordering the coast and extending inland for distances ranging from one fourth mile to slightly more than 3 miles, are gently sloping alluvial fans or terraces, which give way along their eastern border to rolling or steeply sloping hills, or in places to precipitous mountain slopes that rise abruptly from the coastal plain to elevations of 1,700 feet or higher. The hilly areas bordering the coastal plain attain elevations ranging from 500 to more than 900 feet, and they occupy most of the southern part of the area. In the northern and central parts of the area the hilly lands extend inland for a distance of several miles and give way abruptly to steep precipitous mountain slopes that rise to elevations ranging from 1,500 to more than 2,000 feet.[3] Dissecting the hilly lands are a number of streams, bordered by alluvial plains of different widths, that follow a general southwesterly course to the ocean.

The alluvial fans and terraces bordering the ocean are smooth and almost flat, and they are cut at intervals by steep-sided valleys. The surface of the flatter terraces is characterized by alternating low mounds and depressions, referred to generally as constituting a hogwallow topography. Remnants of old elevated coastal beaches, intervening between the coastal plains and the rolling or hilly uplands, lie in the southern part of the area. Granite or other igneous rocks occur in the eastern part of the area, and in some places

[1] STORIE, R. E., and CARPENTER, E. J. SOIL SURVEY OF THE OCEANSIDE AREA, CALIFORNIA. U.S. Dept. Agr., Bur. Chem. and Soils Ser. 1929, Rpt. 11, 41 p., illus. 1933.

[2] ECKMANN, E. C., STRAHORN, A. T., HOLMES, L. C., and GUERNSEY, J. E. SOIL SURVEY OF THE ANAHEIM AREA, CALIFORNIA. U. S. Dept. Agr., Bur. Soils Field Oper. 1916, Rpt. 18: 2271-2345, illus. 1921.

[3] Elevations from United States Geological Survey quadrangles.

in the west-central part, bordering the coast. These rocks have given rise to a generally rough mountainous relief, except in a body lying just south of Santa Margarita River in the southeastern part of the area. Elsewhere the rocks underlying the hilly parts of the area are softly consolidated and have given rise either to gently rolling hills or steeply sloping to rough eroded or broken areas unsuited to any form of agricultural development. Most of the rougher areas border drainage ways and the bases of the higher mountains. The alluvial plains bordering the larger drainage ways are locally somewhat terraced, the elevation of the terraces above the stream channel ranging from 1 to slightly more than 7 feet. The surface of the alluvial plain is generally smooth, except on the lower terraces which may be somewhat gullied by varying currents in time of flood.

Innumerable short drainage ways ramify the area, affording complete drainage to the uplands. Poorly drained areas on the stream flood plains are affected with alkali. In some places the coastal terraces are poorly drained.

The coastal plains and rolling hilly country of the area are grass covered and afford good grazing; the rougher areas are covered with chamiso and other low-growing shrubs, with a few live oaks or white oaks in areas having favorable moisture supply. Sycamore, willows, and a few oaks grow in the bottom lands. The wild tobacco plant is of common occurrence on bottom lands having a good supply of moisture.

Practically all the land included in the Capristrano area was granted by the Spanish Crown, in tracts ranging from 5,000 to more than 40,000 acres, to Spanish subjects between 1837 and 1844. Cattle raising was the principal occupation of the Spanish dons, and the Santa Margarita and Mission Viejo grants, comprising more than 80 per cent of the area, are still intact and used for that purpose though under American ownership. Those parts of the Niguel and San Joaquin grants occurring in the area are controlled largely by a farming syndicate and are sparsely populated. Bordering the coast northward from the Orange-San Diego County line, a number of beach settlements have sprung up within the last 20 years, most of them within 5 years. Aside from the beach settlements and areas in the stream bottoms bordering the coast, which have been developed for the production of cultivated crops, the Capistrano area is largely uninhabited.

The resident population is largely American born and is drawn principally from the Central and Eastern States. A large transient population is drawn to the coast settlements, during the summer months, from the surrounding cities and inland agricultural districts.

The southern part, or about 60 per cent, of the area lies in San Diego County, which was organized February 18, 1850, with San Diego as the county seat. The rest lies in Orange County, which was organized in 1889, with Santa Ana as the county seat. The principal towns of the area are Laguna Beach, with a population of 1,981 in 1930[4]; San Juan Capistrano; and San Clemente, with a population of 667; each having schools, banks, churches, business houses, and other modern improvements. Other post office or railroad points, with populations ranging from 20 to 100, include Deluz, Dana Point, Serra, and San Onofre.

[4] Soil survey reports are dated as of the year in which the field work was completed. Later census figures are given whenever possible

The Atchison, Topeka & Santa Fe Railway affords transportation facilities to the area. Steamship and railroad connections at San Diego and Los Angeles provide transcontinental or transoceanic intercourse. A branch of the Santa Fe Railway leaves the main line at Fallbrook Junction in the southern part of the area and, following up the valley of Santa Margarita River, terminates at Fallbrook just outside the area surveyed. Small piers at Laguna Beach, Capistrano Beach, and San Clemente afford anchorage for fishing boats or small pleasure craft. A stage system operating between Los Angeles and San Diego, with transcontinental connections, passes through San Juan Capistrano and follows the coast from Serra to the south. A local stage system connects with this one at Serra, furnishing transportation to other beach communities to the north, between Serra and Long Beach or Los Angeles.

A paved highway, part of the coast route between San Diego and Los Angeles, borders the coast throughout the length of the area. At Serra a paved road extends up San Juan Creek to San Juan Capistrano, thence north to Santa Ana and connecting highways which reach all important cities and towns in the southern part of the State A paved road connects Laguna Beach with the Santa Ana-San Juan Capistrano Highway at Irvine several miles north of the area surveyed. A well-kept road connects San Juan Hot Spring in the northeastern part of the area with San Juan Capistrano. A well-graded mountain road leads from Deluz to Fallbrook. Most of the other roads throughout the area are private, and gates across them are kept locked to prevent trespassing.

Electric lights, telephones, and modern water systems are available in all the larger communities of the area. Schools, churches, and business houses are conveniently located to serve the needs of the local settlements. Natural gas will soon be available in all the larger settlements in the northern coastal section of the area.

The development of the Capistrano area is retarded somewhat by the large size of the landholdings devoted to livestock raising and grain production. As these holdings are broken up, and water for irrigation and domestic use and better transportation facilities become available, many recreational centers and agricultural industries will probably spring up along the coast.

CLIMATE

The climate of the Capistrano area is characteristic of the Pacific coast region. The winter season is cool and wet, and the summer season is warm and dry. Although similarly contrasting seasons occur in the interior valleys of the region, the climatic features, aside from precipitation, are entirely different. The winters are warmer and the summers cooler bordering the coast, and a relatively high humidity lessens evaporation and transpiration, in contrast to the hot dry atmosphere of the interior valleys during the summer months.

Although the climate of the area is essentially oceanic, the moderating influence of the cool, moist, ocean breezes during the summer is materially lessened as the distance from the coast increases. During this season of the year, fogs drift in from the ocean in the afternoon and blanket the coast, but they rarely extend inland more than a mile or two. In the eastern part of the area the influence of the fogs is slight, though the weather is appreciably cooler and the humidity is higher than in the interior valleys still farther east.

The moderating influence of the ocean has an important bearing on the agriculture of the area. Bordering the coast, grain and bean crops mature successfully without irrigation under a rainfall that would be entirely insufficient in the interior valleys. The amount of water necessary to mature a crop under irrigation is also correspondingly decreased and certain crops requiring high humidity for their successful culture can be grown that otherwise could not be produced.

The rainy season begins in late October, as a rule, and continues until early April. About one-half inch of rain falls during the remainder of the year. The rains come with the wind from the northwest, as a rule, though occasionally from the southwest They are gentle and are absorbed by the soils as they fall, except occasionally, during the spring months when cloudbursts may occur in the mountains to the east accompanied by heavy rains over the valley lands, resulting in erosion and in flooded conditions The eastern part of the area, which lies along the western slope of the Santa Margarita Mountains, receives the highest rainfall.

Table 1 gives the normal monthly, seasonal, and annual temperature and precipitation at Oceanside, which borders the coast just outside the southern boundary of the area.

TABLE 1 —*Normal monthly, seasonal, and annual temperature and precipitation at Oceanside, San Diego County, Calif.*

[Elevation, 60 feet]

Month	Temperature			Precipitation		
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1910)	Total amount for the wettest year (1915)
	°F	°F	°F.	Inches	Inches	Inches
December	55 1	88	31	1 71	0 37	3 12
January	54 4	84	21	3 82	1 62	6 51
February	53 8	82	34	2 39	11	5 75
Winter	54 4	88	21	7 92	2 10	15 38
March	56 8	95	36	1 99	1 76	50
April	59 0	89	39	92	07	2 73
May	61 2	82	44	.22	Trace	51
Spring	59 0	95	36	3 13	1 83	3 74
June	65 2	86	49	10	06	Trace
July	68 8	86	52	04	28	00
August	69 4	86	53	02	01	Trace
Summer	67 8	86	49	16	35	Trace
September	68. 2	106	52	12	.05	Trace
October	64 4	102	43	56	.66	.00
November	60 6	95	33	96	77	65
Fall	64 4	106	33	1 64	1 48	65
Year	61 4	106	21	12 85	5 76	19. 77

Bordering the coast, the range between the day and night temperatures is very slight, but it is somewhat greater in the eastern part of the area. During the summer, the days are warm and the nights are always pleasantly cool. Winds of high velocity are of rare occurrence, and hail and snow are practically unknown.

Bordering the coast many of the higher ridges or terraces are practically frost free, and avocados, winter vegetables, bulbs, and flowers can be grown with a high degree of success. Grapes and citrus fruits, however, are grown most successfully in the eastern part of the area where the daytime temperatures are higher and some localities are practically frost free, though orchard heating would be necessary occasionally for citrus fruits in most places. The average length of the growing season is about 10 months.

Grain and hay crops are planted after the first fall rain and make most of their growth during the winter, or wet season. Native pasture grasses spring up with the first fall rain and make a vigorous growth until the warm dry summer season begins.

In general, the climate of the area is very favorable for the production of many fruits and vegetables, as well as specialized crops, as they may be produced out of doors during the winter in competition with hothouse products from other sections of the country.

AGRICULTURE

The early agricultural history of the Capistrano area is closely interwoven with the history of the San Juan Capistrano Mission. This mission, located on the site of the present town of San Juan Capistrano, was founded in 1776. The grazing of cattle on the open range assumed first importance in the agricultural development of the mission. At an early date, orchards were planted and water was transported in open ditches from the upper San Juan Valley to the vicinity of the mission for use in irrigating the orchards, vineyards, and fields of beans, corn, and wheat. Fruit and grain crops returned good yields, but, owing to lack of markets and transportation facilities, only enough of these crops was produced to supply the needs of the mission Hides and tallow were marketable commodities, and with good grass and plenty of water available the grazing of cattle assumed greater importance from year to year.

About 1843 the missions were secularized, and their influence in the development of the agriculture of the region rapidly declined. The greater part of the land covered by this survey, however, had been granted in large tracts to subjects of the Spanish Crown between 1837 and 1844, and the mission agriculture was succeeded by that of the Spanish dons. Some fruits, cereals, and vegetables were produced on the different grants, though the grazing of cattle continued to be the dominant agricultural industry.

From the agriculture as practiced by the padres and the Spanish dons has developed the agriculture of the present day. Although about 90 percent of the area still lies in large holdings devoted to the grazing of cattle, considerable agricultural development has taken place in some of the valleys where water is available for irrigation. The present-day development indicates the agricultural possibilities of the area as a whole.

Barley and beans are grown successfully under dry-farming practices on the better soils throughout the area [5] On the bottom lands

[5] The Capistrano area lies partly in San Diego County and partly in Orange County and as only a very small proportion of the area surveyed is developed no census data applicable to the agriculture of the area are available Figures given in this report regarding crop acreage, yields, and other agricultural data are from local information or estimates made in the field

under irrigation a variety of truck and fruit crops are grown. Lettuce, spinach, and other hardy vegetables occupy the soils during the winter. Early potatoes and string beans are grown on the terrace lands bordering the coast during the winter without irrigation. Alfalfa is grown on the bottom lands under irrigation and is used to fatten beef cattle; with future development the crop should prove profitable if produced in connection with the dairy industry. Walnuts, oranges, lemons, persimmons, and many other specialized crops are produced under irrigation and indicate possible lines of future development

Approximately 15,000 acres in the Capistrano area are under cultivation at the present time, about 4,000 of which are under irrigation. About 130,000 acres in addition are susceptible of cultivation under future development

Orange groves give variable yields, depending on the season and the condition and age of the trees In general, yields ranging from 300 to 500 boxes an acre are obtained from groves in full bearing. Mature walnut groves return average yields of about 1,500 pounds of walnuts an acre. Barley yields from 10 to 40 bushels an acre, depending on the season and the type of soil. Both lima and blackeyed beans yield from 400 to 1,200 pounds an acre without irrigation. Under irrigation, 2,000 pounds an acre are an average yield, and maximum yields of 4,000 pounds are possible. Lettuce yields average 250 crates an acre, and other truck crops do equally as well.

The average size of privately owned irrigated farms is about 30 acres, and some irrigated farms that are leased by farming syndicates embrace as much as 500 acres. Livestock ranches range from 3,000 to 210,000 acres in size, the latter figure representing the size of the Santa Margarita ranch which lies largely in the area surveyed. Approximately 11,000 range cattle are kept in the area.

At the time of this survey laborers on the cattle ranches were employed largely on a monthly basis at a rate ranging from $45 to $55 and board. Most of the laborers are Mexicans and Filipinos. Mexicans are employed largely on the cattle ranches, on farms devoted to the production of general farm crops, and on the fruit farms during the harvest season.

About 65 percent of the farms of the area are operated by the owners, but the total acreage worked by the owner farmer is much less than that worked by tenants. Practically all the land under cultivation lying within the Santa Margarita ranch, including that in the San Onofre and San Mateo Valleys, is leased to tenants on a share basis. The leases run for a period of a year, and the owner receives one fourth of the crop.

Some ready-mixed mineral fertilizers are used in the citrus groves and on truck land. In general, however, the fruit farmer or the truck farmer depends on plowing under cover crops or other organic matter, such as bean straw or barnyard manure, to maintain fertility.

Farm buildings are modern, and most of them are in a good state of repair. Tractors and other modern farm implements are in general use. Horses are kept on all the grain and livestock farms and on some of the fruit farms. A medium-weight horse is favored by most farmers. Range cattle are of mixed breeds, though Holstein-Friesians and Shorthorns predominate.

The raising of beef cattle is one of the most important agricultural industries of the area. The range is generally fenced into a number of fields, depending on the size of the ranch, the number of cattle, or the condition of pasture. A system of crop rotation is generally followed, whereby each field is left ungrazed every third or fourth year, or oftener if the grass tends to run out. Cattle are grazed over the fields throughout the year, irrespective of the weather or the wetness of the fields. Most of their gain in weight is made during the winter and spring.

The bulls are kept separate from the cows until early spring, when they are turned in with the cows for a period of about three months. No calves are wanted after the last of May. The general average is 1 bull to 20 cows. Calving takes place in the late fall or early spring months when the cows are in good condition and can go into the summer in good flesh.

Steers are marketed when between 2 and 3 years of age. Some scrub calves are marketed younger, and cows that are no longer useful for breeding purposes are marketed when much older. If the market is exceptionally good and the steers are in good condition in the early spring some are marketed directly from the grass, when they will weigh, ordinarily, about 1,000 pounds. As a rule, however, the steers to be marketed are rounded up and put in feed lots about the middle of May and fed a ration of alfalfa meal and rolled barley or cracked corn, about 10 pounds of concentrates to each animal. If barley hay is fed instead of alfalfa, each steer is given about 8 pounds of cottonseed meal instead of the barley or corn. The animals are generally fed for a period of about 30 days, then marketed. As a rule all the livestock to be marketed is disposed of by the first of July.

Some vegetable seeds are produced, including tomato, pepper, eggplant, and squash seed. Tomatoes that are to be picked for seed are left until fully ripe, then harvested. The ripe tomatoes are mashed and put into vats where they are left for about a day and a half to allow fermentation processes to loosen the seed. The slightly fermented tomatoes are placed in flumes supplied with running water which carries off the pulp and allows the seed to settle to the bottom of the flume, from whence it is gathered up and dried and is then ready for market. Eggplant and peppers are treated in much the same manner and squash seed is obtained by merely scraping the seeds from the inside of the squash. Tomatoes yield 150 to 250 pounds of seed an acre and peppers and eggplant yield from 500 to 600 pounds of seed.

Fields devoted to truck crops are generally planted to lettuce in the fall and the crop is off the ground not later than the first of May. The time of harvesting is generally spread over a period of 2 months or longer, beginning in December and continuing until spring. After the lettuce is harvested, the land is prepared for summer crops, such as squash, beans, tomatoes, peppers, or other less hardy crops. Lima beans are planted at different times, from the first of May until late in June or July. Those to be harvested for dry beans are generally planted before the last of May. The later plantings are harvested for green beans, and some of the earlier plantings also, as there is a good market for the green beans.

String beans are planted in the winter to mature early in the spring at which time they command a high price. When frost conditions are

favorable and plenty of moisture is available, yields of nearly 2 tons an acre have been obtained. In less favorable seasons yields may drop as low as 1,000 pounds an acre.

Summer squash is sometimes planted in areas comparatively free from frost in order that it may mature in midwinter, when the demand for fresh vegetables is good and the price is high. Potatoes are also planted on dry-farmed land to mature in the winter and early spring.

Beans are planted on irrigated land used for vegetable production every second or third year. As a rule, the bean straw is turned under following the harvesting of the crop, and applications of barnyard manure are made at regular intervals. Some commercial fertilizer is occasionally applied in the fall before putting the land in lettuce. The most common mixture consists of 8 parts nitrogen, 10 parts phosphoric acid, and 12 parts potash.

Bean straw produced under dry-farm practices is baled and sold as fertilizer for citrus groves. It is a common practice throughout this section to mulch around the base of the trees with a liberal application of bean straw. The prevailing price for the straw is about $10 a ton in the field.

Beans and cereals are generally rotated under dry-farm practices. The yield of barley following beans is nearly double that obtained when no rotation is followed.

SOILS AND CROPS

The Capistrano area is one in which differences in parent material, degree of weathering, mode of accumulation, lime content, and climatic influences have contributed to a great diversity of soils. For purposes of classification, the soils of the area are grouped into soil series, each series including only those soils of similar lime content, color, character of subsoil or underlying parent materials, and degree of weathering The soil series is further subdivided into soil types which are the unit of mapping. Two or more types in a soil series differ from each other essentially only in the matter of texture which is determined by the relative proportion of sand, silt, and clay in the surface soil. Subordinate differences in the character of the soil within a type are designated as phases.

The Capistrano area may be considered a large livestock ranch in which most of the soils are used for grazing. In the small areas under cultivation little or no correlation exists between the type of agriculture practiced and the soil. The availability of irrigation water and frost conditions are more important factors in determining the crops grown in a locality than is the character of the soil, though where conditions are favorable to the production of a diversity of crops, preference is given to those crops best adapted to certain soil types.

For the purpose of discussing the relationship of one soil series or type to another, the arable soils of the area have been classified in four major groups, based on the character of their profiles, their subsoils, and underlying materials. Table 2 gives the series grouping adopted for the area but does not include a group of miscellaneous soil materials that are nonagricultural and have not been differentiated under a series classification. This group includes rough mountainous land, rough broken land, tidal marsh, coastal beach and dune sand, and river wash.

TABLE 2.—*Soil groups in the Capistrano area, California*

Group	Description	Soil series
1	Soils weathered in place from the underlying consolidated bedrock, without pronounced clay accumulation in the subsoil	Fallbrook Vista Escondido Carlsbad Altamont Diablo Linne Ysidora Konokti
2	Recent-alluvial soils, without profile development	Hanford Foster Laguna Cajon Salinas
3	Alluvial soils, with slight accumulation of clay in the subsoil	Botella Clear Lake Elkhorn Farwell Ramona Montezuma Commatti
4	Soils with pronounced clay accumulation in the subsoil	Tierra Las Flores Huerhuero Stockpen Aliso Merriam

Owing to differences in detail in mapping and in observation and study of soil characteristics coincident with the development of the science of soil classification, certain apparent conflicts in classification with previous and inclusive surveys occur. In the later adjoining surveys these differences are owing to minor inclusions and variations in soil character in the vicinity of the boundaries between the areas surveyed.

Conflicts in soil series classification with that of the earlier reconnaissance soil survey of the San Diego region,[6] which covers the Capistrano area in part, are more pronounced and extensive. These are owing to the extensive reconnaissance character of mapping on a small scale in the earlier survey, compared with the detailed mapping in the present survey, and to recognition of many distinct series of soils in the 15 years of intensive study, which have elapsed since the date of the earlier survey.

The more important of these inconsistencies are noted in the following pages, mainly in the section on Soils and Their Interpretation.

Approximately 7 percent of the area is under cultivation, with grain and beans occupying about 70 percent of the cultivated acreage and the remainder devoted largely to truck crops and small acreages of fruits, nuts, alfalfa, and corn. The grazing of beef cattle is one of the most important agricultural industries of the area and about 53 percent of the land is utilized for this purpose. The remainder, or about 40 percent, is brush or forest covered and too rough or mountainous to be of any agricultural value.

The grain crops, consisting of barley and wheat or oats on small acreages, are grown mainly for the grain, though in seasons unfavorable to the production of grain the crop is cut for hay. These crops are produced largely on soils of the Fallbrook, Vista, Altamont, Diablo, and Linne series of group 1, and practically all the soils of group 3

[6] HOLMES, L. C., and PENDLETON, R. L. RECONNAISSANCE SOIL SURVEY OF THE SAN DIEGO REGION, CALIFORNIA. U.S. Dept. Agr., Bur. Soils Field Oper. 1915, Rept. 17: 2509-2581, illus. 1919.

are used to some extent in their production. The grain crops are grown without irrigation as the soils enumerated in these two groups absorb rainfall readily and have about the best water-holding capacity of the soils of the area. The Diablo and Linne soils of group 1 and the Salinas, Clear Lake, Farwell, and Montezuma soils of group 3 have a comparatively high content of organic matter and generally give the best yields. The soils of the Ysidora and Konokti series of group 1 are shallow and are not used in the production of dry-farmed crops. The Escondido soils, however, are deep and of fairly good water-holding capacity, though poor in organic matter. These soils lie in an area used exclusively for grazing, and none of the land is under cultivation. Small areas of the Laguna soils of group 2 are used for grain production though the soils of this group as a whole are rather porous leachy soils that give unsatisfactory yields unless irrigated. The soils of group 4 have a comparatively high water-holding capacity though, owing to their heavy clay subsoils, they give up moisture slowly, and small grains grown on these soils give uncertain yields. The grain crops are grown mostly in the northern part of the area, north and northwest of San Juan Capistrano, but small acreages in the southern part, in the vicinity of Home Ranch, are devoted to these crops.

Lima and blackeyed beans are grown in rotation with the small-grain crops and occupy the same soils in alternate seasons. Moisture conditions are generally the limiting factor in crop yields in the Capistrano area, and the dark-colored soils mentioned, which have a comparatively high organic-matter content and a better moisture supply, return the most satisfactory yields of beans and small grains. A small acreage of beans of both varieties is irrigated each season. Field beans are generally grown in rotation with truck crops or interplanted between young citrus trees, largely on the Laguna soils of group 2 and on the Salinas, Botella, Clear Lake, or Farwell soils of group 3, on which water is available for irrigation.

The soils of group 3 are better adapted to irrigation and return the best yields. All the soils of group 3 have smooth sloping surface relief favorable to irrigation and drainage; they are fertile, absorptive and retentive of moisture, and readily penetrable to plant roots or air. The soils of group 1 are equally well adapted to irrigation, except the areas of steep relief, where an expensive overhead system of irrigation would be necessary to successfully distribute irrigation water. The soils of group 2 are leachy and porous and require more frequent irrigations than the soils of groups 1 and 3. The soils of group 4 are not well adapted to irrigation, owing to the heavy impervious character of the subsoil. Frequent light irrigations must be given these soils and even under the most careful management considerable water logging will occur in depressions that catch free water moving over the top of the heavy clay layer.

The fruit crops, including oranges, a few acres of lemons, and a few small plantings of persimmons, peaches, and grapes, are grown on a variety of soils in the San Juan Valley, which have markedly different agricultural properties. In the Capistrano area these crops can be grown successfully only under irrigation and in a district comparatively frost free. Where such favorable conditions exist, the trees or vines are planted with little regard to soil conditions. As a rule, however, the fruit crops are grown on the Salinas or Botella soils of group 3 or on the Hanford soils of group 2. A few plantings are on the soils

of group 4 and, where the surface soil is fairly deep over the clay subsoil and care is exercised in irrigation, the trees are healthy and return good yields. However, complete failures of small citrus plantings are reported locally on the soils of group 4. In general, the best yields are obtained on the soils of group 3. Under future development, the Fallbrook, Vista, Escondido, Altamont, or Carlsbad soils of group 1 should prove equally as well adapted to citrus-fruit and avocado production as the Ramona, Farwell, Elkhorn, and Botella soils of group 3, where climatic conditions are favorable. Other soils of the area are not considered well adapted to citrus-fruit production, because of poor drainage, shallowness, or impervious subsoils.

Persian (English) walnuts are grown largely in the San Juan Valley in the vicinity of San Juan Capistrano, in association with plantings of citrus fruits. Walnuts occupy about 1,000 acres, which is approximately equivalent to the combined acreage of citrus and other fruits. About 80 percent of the crop is grown on the Salinas and Botella soils of group 3 and the rest largely on the Hanford soils of group 2. These soils are deep, readily permeable, and well adapted to deep-rooted trees. There is very little difference in yields on these soils. Walnuts are grown only under irrigation.

The acreage of alfalfa is fairly constant from year to year, averaging about 800 acres, but the acreage of corn, grown either for livestock feed or as green corn for table use, ranges between 40 and slightly more than 100 acres. Alfalfa is grown exclusively on the soils of groups 2 and 3, the acreage being about equally divided between the two. The Salinas, Foster, and Cajon soils, in the vicinity of Home Ranch on Santa Margarita River, are utilized in the production of this crop. These soils are under irrigation, are readily permeable to roots, contain appreciable lime, and are otherwise well adapted to alfalfa, except in localities where the water table is high. Bermuda grass gives much trouble in areas with a high water table, necessitating reseeding at frequent intervals. Corn is grown on the same kind of soils as alfalfa, generally in connection with other truck crops where intended for table use or in rotation with hay crops when grown for livestock feed. Corn yields are best on the dark soils well supplied with organic matter.

Approximately 130,000 acres of tillable land in the area are used for grazing purposes. This land was acquired at an early date for a low price, and under good range management the production of beef cattle has remained profitable Litigation over the water rights covering a part of the land has also served to delay development. The soils used for grazing purposes include practically every soil type mapped in the area but some soils are conspicuous because of their superior grazing value. Among the good grass soils are the Linne, Diablo, and Altamont soils of group 1, and the Salinas, Botella, Clear Lake, and Commatti soils of group 3. The Linne and Diablo soils are especially good grass soils. The soils of group 4 afford fair grazing though many weeds obnoxious to livestock grow on the soils of this group. The recent-alluvial soils of group 2 afford good grazing in areas having a high water table but elsewhere the grazing qualities of the soils of this group are rather poor. The soils which afford the best grazing are those well supplied with organic matter, that have a high water-holding capacity, and that do not pack or become baked after trampling by livestock. Those soils that are flocculent, owing to a high lime content, possess these qualities to the highest degree.

In the following pages of this report the soils of the Capistrano area are described in groups and in detail and their agricultural relationships are discussed; their location and distribution are shown on the accompanying soil map; and their acreage and proportionate extent are given in table 3.

TABLE 3.—*Acreage and proportionate extent of the soils mapped in the Capistrano area, California*

Type of soil	Acres	Percent	Type of soil	Acres	Percent
Fallbrook sandy loam	1,856	0 7	Clear Lake sandy clay loam	2,304	0 9
Vista sandy loam	10,176	3 8	Elkhorn loamy sand	896	3
Escondido very fine sandy loam	3,200	1 2	Farwell gravelly sandy loam	3,328	1 3
Carlsbad loamy fine sand	3,136	1 2	Farwell gravelly sandy loam, gray phase	320	1
Altamont clay	3,200	1 2	Ramona sandy loam	2,496	9
Altamont fine sandy loam	17,728	6 6	Montezuma clay adobe	768	3
Diablo clay adobe	19,392	7 3	Commatti sandy loam	1,088	4
Diablo clay adobe, steep phase	28,736	10 7	Tierra sandy loam	5,632	2 1
Linne loam	4,352	1 6	Las Flores fine sandy loam	3,840	1 4
Ysidora gravelly sandy loam	4,608	1 7	Las Flores fine sandy loam, friable-subsoil phase	832	3
Ysidora gravelly sandy loam, dark-colored phase	384	1	Huerhuero fine sandy loam	12,032	4 5
Konokti gravelly loam	1,664	6	Stockpen fine sandy loam	2,240	8
Hanford sandy loam	4,736	1 8	Stockpen fine sandy loam, heavy-textured phase	1,216	5
Foster very fine sandy loam	768	3	Aliso fine sandy loam	4,800	1 8
Laguna sandy loam	1,344	5	Merriam sandy loam	1,152	4
Cajon sand	1,728	6	Rough mountainous land	65,472	24 6
Salinas sandy loam	3,456	1 3	Rough broken land	30,784	11 6
Salinas fine sandy loam	4,160	1 6	Tidal marsh	832	3
Salinas fine sandy loam, heavy-textured phase	1,408	5	Coastal beach and dune sand	896	3
Salinas fine sandy loam, light-colored phase	2,432	9	River wash	3,200	1 2
Botella loamy sand	3,520	1 3	Total	267,520	
Botella loamy sand, heavy-textured phase	1,408	5			

SOILS OF GROUP 1

The soils of group 1 are underlain by consolidated bedrock or hardpanlike material, from which they have weathered, at an average depth of about 40 inches. The surface soils are in general friable, and they are underlain by subsoils which are typically somewhat more compact and heavier textured than the surface soils. With the exception of the soils of the Ysidora and Konokti series, which are shallower than is typical of the group, these soils are of high water-holding capacity and where the surface relief is not too severe are well adapted to cultivation. The soils of this group occupy hilly or rolling relief and, as a rule, are comparatively frost free. Where water is available for irrigation, these soils are recognized as being well adapted to the production of citrus and other fruits. The group includes some of the best farming soils in the area.

Fallbrook sandy loam.—The surface soil of Fallbrook sandy loam consists of a 10 or 12 inch layer of dull reddish-brown or brownish-red material. The upper part of the subsoil, to a depth ranging from 26 to 34 inches, is compact brownish-red or dull-red loam or sandy clay loam. This material, in turn, is underlain by a rich reddish-brown loam or sandy clay loam lower subsoil layer that grades into granite bedrock at a depth ranging from 36 to 45 inches. A small included area of finer texture joins with Fallbrook fine sandy loam of the Oceanside area.

The surface soil is low in organic matter, is absorptive of moisture, and is easily cultivated when moist, though it has a tendency to become hard and baked when dry. Considerable angular quartz grit and mica occur in most of the soil. Plant roots, air, and moisture penetrate the soil readily and it has a high water-holding capacity.

This soil occurs only in the east-central part of the area a few miles southwest and southeast of Deluz. About 1 percent of the land is under cultivation to small grains, and the rest is largely brush covered. Small areas are forested with scattered oaks, with grass occupying the intervening spaces Under irrigation citrus and other fruits should prove best adapted to this soil.

Vista sandy loam.—The surface soil of Vista sandy loam, as occurring in this area, consists of dull-brown or dull grayish-brown material, to a depth ranging from 9 to 12 inches, the gray or dull shades of color being most pronounced under dry field conditions. The upper part of the subsoil, to a depth ranging from 32 to 40 inches, consists of slightly or moderately compact dull-brown or brown somewhat heavier textured material, ranging from fine sandy loam to heavy sandy loam. The lower part of the subsoil is dull reddish-brown or dull grayish-brown material of about the same texture, that grades into granite bedrock at a depth ranging from 42 to 50 inches.

The surface soil of Vista sandy loam has a somewhat higher content of organic matter than does the surface soil of Fallbrook sandy loam, and it does not bake so badly on drying. The soil contains appreciable quantities of quartz grit and mica and is easily maintained in good tilth. Under irrigation great care must be exercised in the handling of water, as gully erosion is easily started, even on moderate slopes The soil has a high water-holding capacity and is readily penetrated by plant roots, air, and moisture. This soil occupies hilly or rolling areas and is favored with good drainage.

Several areas occur in the eastern part of the area and in a belt 3 or 4 miles wide extending from the vicinity of Deluz as far south as Morro Hill Two small bodies of Vista sandy loam north of Santa Margarita River at the eastern boundary of the area are grayer than typical and very closely resemble the soils of the Siskiyou series mapped in other parts of the State. Several other bodies contain considerable stone and a few rock outcrops. The stony areas are of lower agricultural value than the typical soil and are shown on the soil map by appropriate symbols. Some of this soil was included with Sierra sandy loam of the earlier reconnaissance survey.

Not more than 2 percent of Vista sandy loam is under cultivation. Barley and wheat, grown largely for hay, occupy more than 70 percent of the cultivated acreage, and small plantings of oranges, peaches, olives, cherries, and grapes occupy the rest of the cultivated acreage. Uncultivated areas are largely brush covered and are of no agricultural value at present. Small grass-covered areas are used for pasture. With future development under irrigation this soil would probably prove to be much better adapted to citrus and other fruits than to grain crops.

Escondido very fine sandy loam.—The surface soil of Escondido very fine sandy loam, to a depth ranging from 10 to 15 inches, consists of pale brownish-red material having a distinct shade of yellow. When wet it is distinctly red, with no indication of a lighter shade of color. The subsoil lacks any evidence of compaction and is of the

same texture as the surface soil. At a depth ranging from 34 to 44 inches is the bedrock of schistose rock, largely basic in character, from which the soil is derived. This soil is distinct from any other residual soil of the area in that it lacks any evidence of clay accumulation or compaction in the subsoil. A few bodies, too inextensive to be differentiated on the map, are of somewhat finer texture than typical

Escondido very fine sandy loam occurs only in the east-central part of the area in a number of bodies in a narrow belt extending northwest from Morro Hill as far as the headwaters of Las Pulgas Canyon. It occupies undulating or hilly areas and is well drained

Part of the land is forested with a scattered growth of oaks and the rest is grass covered and valued for grazing. The soil is easily cultivated, of good water-holding capacity, and in all respects well suited to the production of cultivated crops.

Carlsbad loamy fine sand.—Carlsbad loamy fine sand is characterized by a pale-brown or pale reddish-brown surface soil, ranging from 9 to 12 inches in thickness, that has a distinct shade of yellow when dry When moist the soil is reddish brown. The subsoil, to a depth ranging from 24 to 36 inches, is pale yellowish-brown slightly compact material of the same or only slightly heavier texture than the surface soil This soil is underlain by softly consolidated rust-brown sandstone, the upper 6 to 10 inches of which is more firmly consolidated than the deeper material Water penetrates the variegated rust-brown and gray sandy substratum very slowly.

A few areas of gravelly texture are shown on the soil map by gravel symbols. Such areas are more droughty than typical and the gravel tends to interfere with the cultivation of intertilled crops. The gravelly areas are associated with the typical soil.

The surface soil is low in organic matter and has a tendency to run together when wet and to bake over the surface when dry. Under cultivation the soil retains moisture well but loses it rather rapidly where uncultivated. An appreciable quantity of rounded iron concretions or "shot pellets" are scattered over the surface and are more numerous in the lower part of the subsoil. Under cultivation the soil would be benefited by the addition of organic matter.

This soil has a ridged or moderately sloping fanlike relief. It is developed in a number of bodies in the vicinity of Fallbrook Junction, near Stuart, and north of Dana Point.

About two percent of the land is under cultivation and the rest is largely grass covered and used for grazing. The cultivated areas are used largely in the production of string beans, lima beans, summer squash, early potatoes, and other truck crops. The land is not irrigated, and only winter or early-spring vegetable crops can be grown at present. Localities in which this soil occurs are comparatively free from frost, and with future development of water for irrigation the land should prove valuable in the production of bulbs, vegetables, flower seeds, avocados, and numerous other specialized crops.

Altamont clay.—Altamont clay is characterized by a brown, pale-brown, or yellowish-brown surface soil to a depth ranging from 9 to 12 inches. The subsoil, to a depth ranging from 30 to 40 inches, is moderately compact brown, pale-brown, or light reddish-brown material of slightly heavier texture than the surface soil. The lower part of the subsoil is intermittently calcareous and consists of partly weathered shales or sandstones, from which the soil is derived.

Altamont clay is well supplied with organic matter and is somewhat browner or darker colored than Altamont fine sandy loam. The soil tends to check into irregular blocks or clods on drying if not cultivated. It is rather difficult to handle under cultivation though if worked at the proper moisture content a good granular seed bed can be prepared. The soil has a high water-holding capacity though on account of its heavy texture it gives up moisture slowly and during long hot periods crops soon suffer from lack of moisture. It is a fertile soil and under cultivation gives good yields of grain or hay in favorable seasons. None of the land is under cultivation but it is grass covered and valued highly for grazing. This soil is probably best adapted to general farm crops.

Some of the larger bodies are north of Arroyo San Mateo, bordering Cristianitos Canyon, and near the headwaters of Las Pulgas Canyon. Many small bodies are associated with other residual soils in the hilly country of the northwestern part of the area.

An area of Altamont clay, just north of Serra, has a great number of rounded stones scattered over the surface. This body is shown on the soil map by stone symbols. It differs somewhat from the typical soil in color, ranging from rich brown to dull reddish brown. The stones could be removed from the soil only at great expense, and these areas can probably be used most economically as grazing land. A small area on the northern boundary merges with Altamont loam of the Anaheim area.

Altamont fine sandy loam.—Altamont fine sandy loam differs from Altamont clay in the texture of its surface soil, which is fine sandy loam. It is moderately well supplied with organic matter and under cultivation can be maintained in good tilth It is absorptive and retentive of moisture and is well adapted to cultural practices Local areas occur in which the surface soil closely approaches sandy loam in texture Such areas are small and could not be differentiated Other included areas are of heavier texture than typical and join with Altamont clay loam of the Anaheim area. This soil generally has less lime in the lower part of the subsoil than does Altamont clay.

Large areas of this soil a few miles west of Deluz are somewhat mixed in origin, being derived in part from rocks that are of basic igneous character, but the soil is very much like typical Altamont fine sandy loam in profile, and differentiation on the soil map of the included minor variations was not attempted. Aside from the areas mentioned, smaller bodies occupy the rolling hills south of Arroyo San Onofre and between Arroyo San Onofre and Arroyo San Mateo. Other areas occur just east of San Clemente and north of Laguna Beach.

Less than 1 percent of the land is under cultivation and the remainder supports a few scattered oaks and brush in local areas with native grasses occupying the open spaces. This soil is valued chiefly for grazing though fair yields of hay and beans are obtained on the cultivated land in favorable seasons. Under future development the deeper and more favorably located areas should prove productive of general farm crops and of citrus and deciduous fruits if irrigated

Diablo clay adobe.—Diablo clay adobe has a 9 to 18 inch dark-gray or black surface soil, overlying a subsoil of similar or slightly lighter gray color and of similar or slightly heavier texture. In most places

the subsoil material is compact. Various quantities of lime occur in the subsoil, especially where it grades into parent bedrock of calcareous shale or sandstone at a depth ranging from 30 to 40 inches. Some small included areas are of somewhat brown color resembling the color of the Altamont soils with which they merge

The soil is sticky and difficult to handle when wet but on drying it tends to check or crack into small angular fragments. This structure is not everywhere well developed and the soil joins on the south with Diablo clay of the Oceanside area. The soil is well supplied with organic matter and has a high water-holding capacity, though, as is common with clay soils, it gives up moisture slowly, and during hot spells plants soon suffer from lack of moisture. In cultivating this soil care must be exercised to not work the land when wet as it puddles and is difficult to handle and its agricultural value is lowered for some time thereafter. If worked at the proper moisture content the soil can be easily worked down to a good granular seed bed.

Diablo clay adobe, as mapped in the Capistrano area, includes some bodies occupying the crests of hills or ridges, which are of browner color and lighter texture than typical, closely approaching soils of the Altamont series in character. These bodies are of irregular occurrence, most of them of small extent, and are not differentiated on the map, where intimately associated with the more typical areas. A few small areas of such character join with the Altamont soils of the Anaheim area.

Diablo clay adobe occupies rolling or hilly areas in which drainage is well developed. It is one of the most extensively developed agricultural soils in the Capistrano area. A large number of bodies are in the vicinity of San Juan Capistrano and north, south, and east of that place. Small but prominently developed areas occur a short distance east and northeast of Ysidora. Other bodies are associated with other residual soils in the hilly sections of the area.

Under virgin conditions the soil is grass covered, with only a few oaks in areas protected from the sun, and the land is valued highly for grazing. Approximately 15 percent of the land is under cultivation, with the acreages of barley and beans about equally divided. Less than 10 percent of the cultivated acreage is used for other crops, including wheat, oats, and fruit. Barley is grown both for grain and hay though usually only about 50 percent of the crop is harvested as hay. Lima and blackeyed beans occupy the soil in alternate years. A few acres are devoted to oranges but as a rule yields are not very good. The land appears best adapted to general farm crops.

Diablo clay adobe, steep phase.—A steep phase of Diablo clay adobe is mapped, which differs in no essential respect from the typical soil except in surface relief. Little or none of the steep land is susceptible of cultivation, but under virgin conditions it is well carpeted with grass and is of high value as grazing land in connection with the beef-cattle industry.

In other parts of the State similar grass-covered steep bodies of this soil are used very profitably in connection with the dairy industry. The cattle graze over the land throughout the year, and the cows are milked only during the late fall, winter, and spring months.

This soil occupies smooth steeply sloping hills with rounded tops, in contrast to the eroded, irregular, or broken slopes of areas classed as rough broken land. As mapped these steeper areas may include some undifferentiated bodies of Linne or Altamont soils.

Linne loam.—The surface soil of Linne loam consists of dull brownish-gray or dark grayish-brown calcareous material to a depth of 10 or 12 inches. The subsoil is slightly compact and consists of dark grayish-brown or dull-gray highly calcareous material of about the same or slightly heavier texture than the surface soil. The subsoil is of cloddy structure when disturbed, but it is easily broken to a granular structure under slight pressure. At a depth ranging from 32 to 44 inches the subsoil grades into calcareous shales or sandstones. Above the point where the subsoil grades into bedrock it becomes somewhat grayer and lighter textured than the overlying material.

The surface relief of this soil is rolling or hilly. The soil is well supplied with organic matter and is absorptive and retentive of moisture. It is flocculent and under cultivation can be easily worked into a mellow seed bed. Rodents are very troublesome in this soil and play an important part in bringing subsoil material and fragments of calcareous rock to the surface.

Areas of this soil are widely scattered several miles back from the coast, from the northern to the southern boundaries of the area. Some of the larger bodies are near the headwaters of Aliso Creek and bordering San Onofre and Las Pulgas Canyons, and several areas lie a short distance northeast of Ysidora.

About 25 percent of the land is under cultivation and the remainder supports a vigorous growth of wild grasses including alfilaria, bur clover, and wild oats Barley and beans are grown on about 90 percent of the cultivated acreage, and corn, oats, and wheat are grown on different acreages from year to year. This is one of the most productive soils of the area surveyed, owing largely to its high water-holding capacity, as well as to its inherent fertility. Areas not in cultivation are used for grazing in connection with the beef-cattle industry. Good returns might reasonably be expected from the keeping of dairy cattle Under irrigation avocado production has proved profitable on this soil in adjacent areas. All general farm crops are adapted to the soil.

Ysidora gravelly sandy loam.—Ysidora gravelly sandy loam is characterized by a dull reddish-brown or rich-brown surface soil which extends to a depth ranging from 8 to 12 inches. The subsoil is variable, consisting of dull-brown or dull reddish-brown material that is very compact, but it may range in texture from sandy loam to clay. The heavier subsoil generally occurs in depressions and the lighter-textured subsoil under the mounds that dot the surface. The subsoil is of cloddy structure, and the ease with which it may be broken to a finer structure depends on the texture. Where the subsoil is clay, there is considerable evidence of colloidal deposition in most places. At a depth ranging from 18 to 30 inches the subsoil rests on grayish-brown coarse-textured gritty cemented hardpanlike material, from which the soils have weathered. Alternate small mounds and depressions, commonly referred to as a hog-wallow relief, characterize areas of this soil.

This soil is low in organic-matter content and contains quantities of small or medium-sized rounded or angular gravel that would interfere materially with cultural practices. The soil material is shallow and of low water-holding capacity and is little suited to dry-farming practices. Considerable leveling would be necessary before the land

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could be irrigated, and under irrigation, the variable character of the subsoil and the presence of the impervious substratum near the surface would materially limit the value of the soil.

The soil occupies sloping or gently rolling and terracelike areas. One of the largest bodies borders Bell Canyon in the northeastern part of the area, and others occur at short distances northwest of Ysidora and at other places throughout the area surveyed, generally occupying terraces bordering the larger streams. None of the land is under cultivation, neither is it adapted to cultivation under future development. Under virgin conditions it is partly brush covered and partly open and grass covered. It has low value for grazing.

Ysidora gravelly sandy loam, dark-colored phase.—A dark-colored phase of Ysidora gravelly sandy loam occurs, in which the surface soil is dull grayish brown or dark brown, and the subsoil is dull grayish-brown or drab clay. The soil rests on bedrock of hardpanlike material at a depth ranging from 18 to 26 inches. Soil of this phase represents a minor development of soil classified in other areas in the State in the Chamise series. Its surface relief is similar to that of the typical Ysidora soils. It occurs only in two small bodies, having a total area of less than 400 acres, at the headwaters of Las Pulgas Canyon. The land is largely brush covered and has little present or potential value for agriculture.

Konokti gravelly loam.—The 8- or 10-inch surface soil of Konokti gravelly loam consists of dull reddish-brown or brown material which has a distinct red color when wet. The upper part of the subsoil, to a depth ranging from 30 to 35 inches, is dull reddish-brown or dull brownish-red slightly compact gravelly material that ranges in texture from loam to clay loam. The lower part of the subsoil, to a depth ranging from 40 to 50 inches, is red or dull-red compact gravelly clay or clay loam which grades into bedrock of schistlike gravel consolidated into a conglomeratelike rock (pl. 1, A). The surface soil is slightly compact under virgin conditions but it breaks up readily into a granular mass when disturbed. Compaction and the development of structure gradually increase with depth until the lower subsoil is reached where an appreciable clay and colloidal accumulation and a faint development of a columnar structure exist. The transition from soil to bedrock is more abrupt in this soil than in soils developed on granite. Angular or subangular medium-sized gravel constitute from 20 to 30 percent of the soil mass. The gravel not only interfere with cultural operations but tend to make the soil more droughty than it would otherwise be. The soil is moderately well supplied with organic matter and has fair water-holding capacity. It occupies sloping fanlike areas as well as undulating and hilly areas.

This soil is prominently developed along the western foot slopes of the San Onofre Mountains, bordering the coast. A comparatively large body is near the headwaters of Arroyo San Onofre. None of the land is under cultivation but is largely open and grass covered, with some forested areas. The land is not adapted to the production of dry-farmed crops, though under irrigation it should be valuable for the production of tree fruits and berries.

Included with Konokti gravelly loam, because of their small extent, are two bodies of soil derived from basaltic rocks, having duller-brown surface soils and slightly compact subsoils of about the same color.

One body of this character is 2½ miles east of San Onofre and the other borders the coast just south of Aliso Point. None of the land is under cultivation but with future development it should prove adapted to about the same crops as are grown on typical Konokti gravelly loam.

SOILS OF GROUP 2

The soils of group 2 are characterized by loose porous surface soils and subsoils. They occupy stream bottoms that are subject to overflow at intervals. The soils, as a rule, require frequent applications of water for maturing a crop under irrigation. They are best adapted to deep-rooted crops, especially those less susceptible to frost injury.

Hanford sandy loam.—Hanford sandy loam is characterized by a brown or dull-brown surface soil extending to a depth ranging from 10 to 14 inches. The subsoil to a depth of 72 or more inches consists of friable stratified sediments which are of the same color as the surface soil. This soil is an unweathered recent-alluvial deposit of granitic origin. It contains considerable quartz grit and mica and in places grades into coarse sandy loam or fine sandy loam. Small areas of the latter inclusion join with Hanford fine sandy loam of the Oceanside area. The subsoil is of variable texture but generally consists of loose porous sediments that are of low water-holding capacity

This soil occurs only in the stream bottoms in the northern and eastern parts of the area. Only three bodies of the typical soil are in the area, one at Deluz, one in a minor drainage way west of Morro Hill, and the third, which is of fine sandy loam or silt loam texture, at Serra. A number of nontypical areas are included with this soil as mapped, because of their small extent. Some of these differ from the typical soil only in the degree of weathering. In such bodies the subsoil is slightly compact and of heavier texture than the surface soil. If more extensively developed they would be recognized as soils of the Greenfield series mapped in other parts of the State. Small areas of such character join with Greenfield sandy loam of the Oceanside area. Bodies of this included soil have higher agricultural value than typical Hanford sandy loam. Several areas of this character border Santa Margarita River in the eastern part of the area, and others occupy slightly elevated terraces in the vicinity of Deluz. A few small areas of dark grayish-brown or dull grayish-brown recent-alluvial soils, which are derived from granite and have more or less lime in the surface soil or subsoil, are also included in mapping. A body of this character covering about 80 acres occupies the stream bottom at Deluz Station, and another covering about 30 acres is 1½ miles northwest of Morro Hill. A large number of areas of this soil that occur in Arroyo San Onofre and in stream bottoms north and west of that stream are of mixed origin though derived largely from granitic rocks. The subsoil of the soils in these localities may be slightly calcareous in local areas, and the surface soil averages somewhat lighter colored than typical. Gravelly bodies of the soil are somewhat more porous and leachy than those without gravel and have been shown on the soil map by gravel symbols.

Less than 2 percent of the land is under cultivation, and the remainder is largely grass covered and sparsely forested with sycamore and oak. The cultivated areas are irrigated and used in the production

of a great variety of crops, including walnuts, peaches, apples, persimmons, and different truck crops. This soil is adapted to a wide range of crops and returns good yields if irrigated.

Foster very fine sandy loam.—Foster very fine sandy loam is composed of recent-alluvial material derived mainly from granitic rocks. The surface soil, to a depth ranging from 9 to 12 inches, is dark grayish-brown calcareous material containing large quantities of mica. The subsoil, to a depth of more than 6 feet, is slightly grayer than the surface soil, is highly calcareous, and of stratified character. Subdrainage is restricted in most places, and the soil contains more or less alkali.

The surface soil is well supplied with organic matter, and the soil has a good water-holding capacity. It is easily cultivated and maintained in good tilth and is highly productive when free from injurious accumulations of alkali.

This soil occurs only on the bottom lands of Santa Margarita River. Two rather large bodies occur, one at Chappo and the other at Ysidora, and a small area of about 15 acres is a mile north of Fallbrook Junction.

About 35 percent of the land is under cultivation. Most of the remainder is affected with injurious quantities of alkali and supports alkali-resistant grasses or weeds. About 70 percent of the cultivated acreage is devoted to truck crops and the rest to alfalfa. The soil is well adapted to these crops.

Laguna sandy loam.—The surface soil of Laguna sandy loam, to a depth ranging from 10 to 15 inches, consists of brownish-gray or dull brownish-gray material. The subsoil, to a depth of more than 6 feet, is dull-gray or dull brownish-gray material of stratified character. In general, the subsoil contains strata of heavier-textured material than the surface soil, or in local areas is somewhat compact, owing to weathering. The soil is of mixed origin. It contains considerable rounded quartz sand and is low in organic matter. It is easily cultivated, though it tends to run together when wet and to bake when dry if not cultivated.

This soil occupies alluvial fans and stream bottoms and is subject to occasional overflow. Two bodies are north of San Onofre, one a half mile north of the railway station and the other in Cristianitos Canyon. A number of small areas occupy stream bottoms north and northeast of Las Flores.

Virgin areas are grass covered and dotted with a few oaks and sycamores. About 10 percent of the land is under cultivation, most of which is devoted to bean production without irrigation. The yields are uncertain, especially in seasons of low rainfall. Under future development the soil should prove best adapted to general farm crops. The turning under of organic matter would prove especially beneficial.

Cajon sand.—Cajon sand is composed of a light brownish-gray or dull brownish-gray calcareous surface soil from 10 to 14 inches thick, overlying a stratified subsoil of the same character that extends to a depth of more than 6 feet. This soil is loose and friable, without evidence of compaction or weathering in any part of the profile. It is of granitic origin and occupies stream bottoms or alluvial fans subject to periodic overflows.

As occurring in the Capistrano area, this soil is in many places only slightly better than river wash, and the texture changes within short distances from sand to fine sand or coarse sand. The subsoil, in

most places, is composed of coarser and more porous sand than the surface soil. The soil is low in organic matter and is leachy and porous. Most of the areas have poor subdrainage and contain slight accumulations of alkali.

Several hundred acres of this soil lie in the Santa Margarita River bottom between Home Ranch and Ysidora, other areas are in the lower part of San Juan Valley, and comparatively small bodies occur in the lower part of Arroyo San Mateo Valley. About 1 percent of the land is under cultivation and is used in connection with better soils. The cultivated areas are under irrigation and fair yields of deep-rooted crops are obtained. Virgin areas support a scattered growth of willow, wild tobacco, and sycamore. Salt grass grows well in the wetter alkali-affected areas, and other grasses afford fair pasture on the better-drained areas during the winter months The soil has a comparatively low value for agriculture and it is unsuited to cultivation without irrigation. The better-drained areas protected from flood waters should prove best adapted to deep-rooted tree crops or alfalfa.

SOILS OF GROUP 3

The soils of group 3 are deep. They have permeable surface soils underlain by slightly or moderately compact and heavier-textured subsoils that are only slightly less permeable to air and moisture than the surface soils. These soils have a high water-holding capacity, are generally fertile, and are adapted to practically all crops grown in this region. They occupy low terraces and in some places are subject to frost, thus rendering them less well adapted to the production of subtropical fruits than the soils of group 1. The soils of this group differ from those of group 2 in having heavier-textured and more compact subsoils, rendering them less droughty, and they differ from those of group 1 in being underlain by unconsolidated sediments to a depth ranging from 6 to more than 10 feet.

Salinas sandy loam.—Salinas sandy loam has a dull dark grayish-brown or dull-brown surface soil ranging from 7 to 10 inches in thickness. The upper part of the subsoil, to a depth ranging from 20 to 36 inches, is of similar color and of the same or slightly heavier texture. It differs from the surface soil, however, in being of a more cloddy structure. The lower part of the subsoil to a depth of 72 or more inches is moderately compact calcareous material of about the same texture as the surface soil but of lighter-brown or light grayish-brown color. The Salinas soils are derived from moderately weathered old valley-filling deposits of mixed origin. They occupy alluvial fans and terraces lying several feet above the high-water mark of the bordering streams. The surface soils contain moderate quantities of organic matter and show evidence of considerable reworking by worms and burrowing animals. In most places, the soils are of cloddy structure when plowed, but they are easily worked down to a granular condition. The subsoils are noticeably compacted and typically tend to be slightly heavier in texture than the surface soils, owing to weathering processes which have translocated clay and colloidal material from the upper layers to the subsoils. The subsoils effervesce in acid but show no visible segregation of lime such as occurs in some of the older soils.

The surface soil of Salinas sandy loam is loose and friable under cultivation, though it tends to run together when wet and to bake when dry if not cultivated. The soil has a comparatively high water-holding capacity and is well adapted to cultural or irrigation practices.

As mapped, the soil includes several bodies which differ from the typical soil in being lighter colored, ranging from light brown to light grayish brown, and in having less compact subsoils. Such areas have a slightly lower water-holding capacity than the typical soil. Bodies of this character occupy the greater part of Arroyo Trabuco, as well as considerable areas in the lower parts of Arroyo San Onofre and Arroyo San Mateo. Other areas of this character are in San Juan Valley east of the junction of Canada Gubernadora with this valley. Most of the typical bodies of this soil are small and widely scattered. Areas occur just southwest of Home Ranch and in the upper part of Canada Gubernadora. Numerous smaller bodies are at different places associated with other alluvial soils in creek bottoms throughout the area surveyed, particularly near the headwaters of Las Pulgas and Aliso Canyons.

About 25 percent of the land is under cultivation and is valued highly in the production of truck crops, walnuts, and alfalfa, under irrigation, and for the production of barley and beans under dry-farm practices. Barley is cut for hay in seasons unfavorable to the production of grain. Virgin areas support scattered oaks and sycamores, with native grasses, which afford good grazing, occupying the open spaces. Irrigated bodies of this soil comprise more than 70 percent of the cultivated acreage and truck crops occupy about 75 percent of the land under irrigation. Walnuts, alfalfa, and small acreages of fruit crops occupy the rest of the irrigated acreage. Crops produced under irrigation return very good yields, as do those produced under dry-farm practices in ordinary seasons. Salinas sandy loam is adapted to practically all crops grown in this region, though frost conditions limit certain crops in local areas.

Salinas fine sandy loam.—Salinas fine sandy loam differs from Salinas sandy loam only in the finer texture of the surface soil. It has a somewhat better water-holding capacity and for this reason is better suited to irrigation and cultural practices. The soil has a fair organic-matter content and is easily cultivated and maintained in good tilth. Plant roots, air, and moisture penetrate the soil readily. Local areas are somewhat darker colored than typical, closely approaching in color the soils of the Clear Lake series.

Salinas fine sandy loam is extensively developed along Aliso Creek in the northern part of the area. A number of bodies occur along San Juan Creek and its tributaries and at various other places in the area, associated with other alluvial soils.

About 80 percent of the land is under cultivation, with less than 5 percent under irrigation. The irrigated areas are used in the production of truck crops and lima beans, harvested either as green or dry beans. Under dry-farm practices about 70 percent of the cultivated area is used in the production of lima or blackeyed beans and the remainder is used in the production of grain crops. This is a productive soil, well farmed, and regarded highly for agriculture. The land can be maintained in a highly productive state by using good cultural practices including the turning under of organic matter and the practice of a rotation. The soil is adapted to practically all crops grown in this region.

Salinas fine sandy loam, heavy-textured phase.—The heavy-textured phase of Salinas fine sandy loam consists of a clay loam surface soil overlying a subsoil of similar or slightly heavier texture and containing an appreciable accumulation of lime. The soil is well supplied with organic matter and is equally as well adapted to cultural practices as typical Salinas fine sandy loam.

This heavy-textured soil is most typically and extensively developed in lower San Juan Valley and small bodies occur in numerous other places throughout the area. About 80 percent or more of the land is under cultivation, with more than half of the cultivated acreage under irrigation and utilized largely in the production of walnuts. Grain and beans are grown without irrigation and they give very good yields in normal seasons. Land of this character is fertile and is as well adapted to crop production as typical Salinas fine sandy loam.

Salinas fine sandy loam, light-colored phase.—The light-colored phase of Salinas fine sandy loam is characterized by a gray or light brownish-gray calcareous surface soil extending to a depth ranging from 9 to 12 inches. The subsoil to a depth of 72 or more inches is gray or light brownish-gray calcareous material of about the same texture as the surface soil but of stratified character. It differs from the typical Salinas soil in its lighter color, its looser subsoil, and in the calcareous character of both the surface soil and subsoil materials.

This light-colored soil is low in organic matter, though, owing to its high lime content, it is flocculent and easily maintained in good tilth. It is readily penetrated by plant roots, air, and moisture and under cultivation is absorptive and retentive of moisture, rendering it well adapted to irrigation and cultural practices. This soil occupies gently sloping alluvial fans and stream bottoms. It is well drained except in local areas on stream bottoms subject to seepage or during periods of overflow.

A few small undifferentiated bodies that differ very markedly from the typical soil are darker gray or black in the surface soil, and the subsoil is of similar or somewhat grayer color. Both surface soil and subsoil are highly calcareous, and the texture ranges from clay loam to clay. Areas of this character occur in localities subject to poor drainage and favorable to the accumulation of organic matter. The largest body of this kind is above the mouth of Canada Gubernadora. Smaller areas are 2 miles east of Ysidora, a mile north of Chappo, and near the mouth of Las Pulgas Canyon.

Areas of Salinas fine sandy loam, light-colored phase, occur near the mouth of Las Pulgas Canyon, along Aliso Canyon, and in the bottoms of Arroyo San Mateo, Santa Margarita River, and San Juan Canyon. A small area joins with similar material which was included with Yolo clay adobe in the Anaheim area.

About 20 percent of the land is under cultivation and the rest is grass covered and used for grazing land. Cultivated areas are devoted largely to the production of barley and beans, more than 70 percent being devoted to barley. The soil is dry-farmed and crop yields are dependent on seasonal rainfall. Under irrigation this soil should prove well adapted to alfalfa and general farm crops as well as to truck crops. Turning under organic matter would increase the fertility of the soil and improve its water-holding capacity.

As mapped this soil incudes some lighter-textured areas in which the surface soil and subsoil are of lighter texture and more leachy. These areas are less well adapted to the production of dry-farmed crops. They occupy the greater part of the stream bottom in Las Pulgas Canyon and occur at various places in the bottoms of San Juan Canyon and its tributaries. About 2 percent of the land in these areas is under cultivation, producing fair crops of barley or wheat hay in favorable seasons. Uncultivated areas are at present valued only for grazing.

The soil also includes small areas having light grayish-brown or dark grayish-brown calcareous surface soils and subsoils. The soil is moderately well supplied with organic matter, is easily cultivated and has a good water-holding capacity. Areas of this character occur on stream bottoms or alluvial fans having somewhat restricted drainage. Under irrigation they would require artificial drainage in some places. They are most extensively developed in San Juan Canyon both north and south of San Juan Capistrano. Smaller bodies lie near the mouth of Las Pulgas Canyon. About 35 percent of this included soil is irrigated and is used in the production of walnuts and to less extent of oranges or other fruits. About 45 percent of it is devoted to grain-hay or bean crops produced without irrigation and the remainder is grass covered and used as grazing land. The soil is well adapted to truck crops, walnuts, and general farm crops.

Botella loamy sand.—The surface soil of Botella loamy sand is dark-brown or dull grayish-brown material to a depth ranging from 8 to 12 inches. The upper part of the subsoil to a depth ranging from 30 to 40 inches consists of dark grayish-brown or dull grayish-brown slightly compact material, usually of slightly heavier texture than the surface soil. The lower part of the subsoil to a depth of more than 6 feet is slightly compact material of about the same texture as the surface soil but of somewhat grayer color. The surface soil is moderately well supplied with organic matter and, owing to interlacing of innumerable grass roots and reworking by animals, the soil has a granular structure when disturbed. The upper subsoil layer is without definite structure though it breaks up cloddy when disturbed. Imperfectly developed cleavage lines that will, in the course of weathering, develop a prismatic or columnar structure occur in the lower subsoil layer, but at present this layer breaks into coarse clods that may be broken down under moderate pressure. The Botella soils are of mixed origin and occupy alluvial fans and terraces slightly higher than the recent alluvial soils which they border. These soils are similar to the Salinas soils except that they contain no lime in any part of the soil profile.

Botella loamy sand has a loose friable surface soil that is easily cultivated and maintained in good tilth. The subsoil is slightly compact, has a good water-holding capacity, and is readily penetrated by plant roots. This soil is favored with good drainage and under virgin conditions is moderately well supplied with organic matter

A few undifferentiated bodies of fine sandy loam or loamy fine sand texture are included with the soil as mapped because of their small extent. The soil in such areas has a slightly better water-holding capacity and a higher agricultural value than the typical soil. The soil also includes about 400 acres of brown or light-brown soil that is derived very largely from outwash material from sedimentary rocks. The soil in such areas is similar to typical Botella loamy sand, except

that it contains less organic matter and is usually of slightly heavier texture. The included areas of browner soil occur only near the heads of Piedra de Lumbre Canyon and Horno Canyon, and areas of the finer-textured inclusion occur only near the mouth of San Onofre Canyon.

Typical bodies of loamy sand texture are in the lower San Juan Valley, in Canada Gubernadora and Canada Chiquita. A few other small areas are in stream bottoms along the southern boundary of the area surveyed.

About 50 percent of the land is under cultivation, with only a very small proportion under irrigation. Irrigated areas are used very largely for truck crops, and land not under irrigation is devoted to bean production, with small acreages in grain. This soil is productive and adapted to the same range of crops as Salinas sandy loam.

Botella loamy sand, heavy-textured phase.—A heavy-textured phase of Botella loamy sand is mapped, in which the surface soil is clay loam. In other respects the soil does not differ from typical Botella loamy sand. The heavy-textured soil, however, is more difficult to handle under cultivation, though it has slightly better moisture-holding properties.

Small areas of Botella loamy sand, heavy-textured phase, occur along Arroyo San Onofre, and in San Juan Valley in the vicinity of San Juan Capistrano. A few bodies, comprising a total of less than 80 acres, are along the southern boundary of the area.

About 40 percent of this heavy-textured soil is under irrigation and is used largely in the production of walnuts and various fruits, and the remainder, which is largely grass covered, is valued only for grazing. Under future development this soil should prove well adapted to truck crops, alfalfa, and general farm crops, as well as nuts.

Clear Lake sandy clay loam.—Clear Lake sandy clay loam is characterized by a dark-gray or black surface soil to a depth ranging from 10 to 14 inches. The upper part of the subsoil to a depth ranging from 36 to 45 inches is of similar color, moderately compact, of slightly heavier texture, and contains some lime. The lower part of the subsoil to a depth of 72 or more inches is light brownish-gray or dull brownish-gray material of slightly heavier texture than the surface soil and is well supplied with lime. A cloddy structure characterizes the subsoil as in other immaturely weathered soils of the area. The lower part of the subsoil in most places is slightly mottled with rust brown and yellow. The soil is of mixed origin and occupies flat terraces or stream bottoms, having poorly developed subdrainage.

The surface soil is well supplied with organic matter, is absorptive and retentive of moisture, and under cultivation may be worked into a mellow seed bed, if cultivated at the proper moisture content. On account of restricted subdrainage this soil is not so well adapted to irrigation as soils with well-developed drainage.

Clear Lake sandy clay loam is prominently developed in Aliso Canyon, Canada Salada, and Canada Chiquita. A number of small bodies, ranging in size from 10 to 60 acres, are scattered throughout the area, in association with other bottom-land soils

Practically none of the land is under cultivation at the present time, but it is grass covered and valued highly for grazing. With future development and drainage the soil should prove well adapted to alfalfa, beans, corn, and truck crops.

Elkhorn loamy sand.—Elkhorn loamy sand has a grayish-brown, dul grayish-brown, or somewhat richer brown surface soil to a depth ranging from 12 to 18 inches. The upper part of the subsoil to a depth ranging from 45 to 54 inches is yellowish brown or pale reddish brown and of about the same texture as the surface soil. This layer is friable, with little evidence of compaction when moist, but on drying the material becomes very firm or partly cemented and is very difficult to dig into. The lower part of the subsoil to a depth of more than 72 inches is slightly less compact than the overlying material and is of yellowish-brown or light-brown color. On drying it shows no lines of breakage. It is but very little heavier in texture than the surface soil but is more compact. This soil is developed on slightly weathered marine-terrace materials.

The surface soil is loose and friable and contains a small or moderate amount of organic matter. The soil is favorable to irrigation, and it has a fair water-holding capacity. Unless cultivated, however, it has a tendency to run together and bake on drying and to lose moisture very rapidly. A comparatively high content of rounded quartz sand gives the surface soil a grayer appearance when dry than when moist. When moist it is of rich-brown or dull reddish-brown color.

This soil occurs only on the coastal terraces, one of the largest bodies lying just northwest of Dana Point. Smaller areas are on both sides of Santa Margarita River at the point where this river empties into the ocean. A few small bodies are developed in other parts of the area, associated with other coastal-plain soils.

About 10 percent of the land is under cultivation at the present time, and the rest is used as pasture land. Early truck crops are grown without irrigation and yields depend largely on climatic conditions. Under irrigation this soil is valued highly for vegetable, bulb, avocado, and other fruit crops in adjacent areas.

Farwell gravelly sandy loam.—Farwell gravelly sandy loam has a dark grayish-brown or dull chocolate-brown surface soil to a depth ranging from 10 to 14 inches. The upper part of the subsoil to a depth ranging from 40 to 50 inches is moderately compact material of similar or slightly heavier texture and similar or darker-brown color. The lower part of the subsoil to a depth of more than 72 inches is lighter-brown or lighter reddish-brown calcareous material of about the same or somewhat lighter texture than the overlying material. The Farwell soils are of mixed origin, though they are derived largely from basic schists. They occupy alluvial fans and terraces slightly above overflow of the bordering streams. The structural development and compaction of the subsoil are about the same in these soils as in soils of the Salinas series. They differ from the Salinas soils, however, in being of richer-brown color and in being derived largely from basic material. The gravel in this soil consists largely of flat angular fragments of basic schistlike rock and constitutes from 15 to 30 percent of the soil mass. The gravel interferes somewhat with cultural operations, otherwise the soil is easily cultivated and maintained in good tilth. It has a good water-holding capacity and is retentive of moisture under cultivation, though it loses moisture rather quickly if not cultivated.

Two bodies, which do not contain gravel and are of loam texture, are included with this soil as mapped. The soil in these areas is better adapted to cultural practices and is more retentive of moisture

than the typical soil. One such body is at Don and the other is a mile northwest of that place. Typical areas of Farwell gravelly sandy loam border the coast from Las Pulgas Canyon north as far as Arroyo San Onofre. Others are in the vicinity of Arch Beach, and small areas are in Canada Salada and in Laguna Canyon.

About 75 percent of the land is under cultivation and is devoted largely to beans, with smaller acreages of grain. Some melons, tomatoes, and other vegetable crops are grown. None of this soil is under irrigation, but with future development it should prove valuable in the production of all crops suited to local climatic conditions. The soil is fertile and the fertility can be maintained by observing good farm practices.

Farwell gravelly sandy loam, gray phase.—A gray phase of Farwell gravelly sandy loam is mapped, which differs from the typical soil only in that the surface soil and subsoil are dull brownish gray and in that it contains appreciably more gravel than does the typical soil. Land of this character has a lower agricultural value than the less gravelly soil. The gray areas are associated with the typical soil, bordering several of the drainage ways that traverse the soil. One of the largest bodies lies at the mouth of Horno Canyon and two areas are a short distance northwest of that place. Nearly all the land of the gray phase is utilized in the production of beans, and a smaller acreage is devoted to grain. It is adapted to the same crops as the typical soil but has a slightly lower agricultural value.

Ramona sandy loam.—Ramona sandy loam is characterized by a rich-brown, dull-brown, or somewhat grayish brown friable surface soil to a depth of 10 or 12 inches. The upper part of the subsoil to a depth ranging from 45 to 50 inches is compact reddish-brown or pale reddish-brown material of heavier texture than the surface soil. The lower part of the subsoil to a depth of more than 72 inches is pale reddish-brown material which is less compact than the overlying material and is of similar or lighter texture. Under virgin conditions the Ramona soils contain a slight quantity of organic matter in the surface soil, but this is soon lost after a few years of cultivation. The surface soils are granular but the subsoils are moderately compact and of cloddy structure. A noticeable accumulation of clay and colloidal material occurs in the subsoil, and breakage lines are fairly well developed. These soils are derived from moderately weathered alluvial deposits of granitic origin.

The upper part of the subsoil is of sandy clay loam or clay texture, and though moderately compact it is readily penetrated by plant roots, air, and moisture. The surface soil has a high water-holding capacity and is well adapted to irrigation and cultural practices. It is comparatively poor in organic matter and tends to bake and dry quickly if not cultivated.

Some variation in color occurs in the soil as mapped, in which the surface soil consists of dull grayish-brown material. A few bodies contain considerable stone scattered throughout the soil mass. They are shown on the soil map by stone symbols, and most of them are along Deluz Creek. Such areas are of lower agricultural value and would require much labor and expense to remove the stone before cultivation.

Typical areas of this soil lie along Deluz Creek, north of Deluz, and bordering Santa Margarita River in the vicinity of Home Ranch and north of that place. A comparatively large body is north of Fallbrook Junction.

About 20 percent of the land is used in the production of grain hay, and less than 10 percent is used in the production of beans, fruit, and a number of vegetables. None of the land is under irrigation, and crop yields, especially of grain, are generally light. Under irrigation this soil should prove one of the most valuable in the area in the production of citrus, berry, and other fruit crops. It is generally low in organic matter and this should be supplied under irrigation either by turning under cover crops or by applying barnyard manure.

Montezuma clay adobe.—In most places the surface soil of Montezuma clay adobe is dark-gray or black heavy-textured material to a depth ranging from 15 to 30 inches. The upper part of the subsoil, to a depth ranging from 36 to 45 inches, is of about the same texture and color as the surface soil, but it is slightly compact and contains lime accumulations, as gray nodules or soft segregations, in root holes or cavities. The lower part of the subsoil, to a depth of more than 6 feet, is light brownish-gray or light grayish-brown slightly lighter textured material that contains only a few lime-carbonate accumulations. The Montezuma soils have a partly developed jointed or columnar structure in the subsoil, as a rule, and a cubical structure in the zone of lime accumulation. They are of mixed origin and slightly older than other soils of the moderately weathered group. They occupy alluvial fans or terraces.

This soil is difficult to handle under cultivation, and care must be exercised not to work it when too wet as puddling will result. If worked at the proper moisture content, however, it will crumble to a friable consistence and a good mellow seed bed may be prepared. It is well supplied with organic matter and is fertile, though, as is common to all clay soils, it gives up moisture slowly, and under dry-farm practices crops soon suffer during hot spells from lack of moisture.

The largest bodies of this soil border Arroyo Trabuco and the smaller drainage ways just west of that stream. A small area is at San Juan Capistrano, and another borders San Juan Creek about 2 miles east of that place. A small body joins with an area of Ramona loam of the Anaheim area with which it merges.

About 25 percent of the land is cultivated, and the rest supports a good growth of grasses that are valued for grazing. Barley, produced either for grain or hay, occupies practically all the cultivated land and returns fair yields in good seasons. This soil is best adapted to general farm crops.

Commatti sandy loam.—Commatti sandy loam is characterized by a dull-gray or dull brownish-gray surface soil from 10 to 15 inches thick. The upper part of the subsoil to a depth of 40 or 50 inches is of similar color but is slightly compact calcareous material of about the same or slightly heavier texture. The lower part of the subsoil to a depth of more than 6 feet consists of light-gray or light brownish-gray slightly compact calcareous material of about the same texture as the surface soil. The subsoil has a cloddy structure when dis-

turbed that may be easily reduced to a granular structure. This soil occupies alluvial fans and terraces in which the parent materials are derived mainly from sedimentary rocks.

The soil is low in organic-matter content, though it has a good water-holding capacity and is friable and easily pulverized to a mellow seed bed under cultivation. The soil is well drained, easily penetrated by plant roots, air, and moisture, and otherwise well adapted to irrigation and cultural practices.

This is an inextensive soil. The largest body occupies the greater part of the creek bottom north of San Juan Capistrano, and other areas lie in a creek bottom about 5 miles east of that town. Bodies of local importance are in Las Pulgas and Piedra de Lumbre Canyons and bordering Santa Margarita River northwest of Chappo.

About 50 acres of this soil are under cultivation, and most of the cultivated land is irrigated. Beans, other vegetables, walnuts, and various fruits return good yields where climatic conditions are favorable. Uncultivated areas are grass covered and support a few oaks. The soil is well adapted to irrigation and the production of alfalfa. This crop, produced in connection with the dairy industry, should prove profitable under future development.

SOILS OF GROUP 4

The soils of group 4 are distinctive. They have friable surface soils to a depth ranging from 8 to 18 inches, giving way abruptly to heavy intractable clay which is practically impervious to plant roots, moisture, and air. The clay layer may be underlain at a depth of 2 feet or more by partly consolidated bedrock or, in many places, by unconsolidated but extremely compact sediments. The soils of this group occupy elevated terraces or, in places, rolling or undulating hills. Under irrigation these soils are probably best adapted to shallow-rooted annuals or vines.

Tierra sandy loam.—Tierra sandy loam is characterized by a dull-brown or dark grayish-brown surface soil to a depth ranging from 8 to 12 inches. This gives way abruptly to dark-gray or grayish-drab sandy clay or sandy clay loam, that is extremely tight and compact. When wet this material is plastic and tough, but on drying it breaks into irregular columns the tops of which are rounded and coated with gray. At a depth ranging from 24 to 32 inches, this heavy-textured layer is underlain by dull brownish-gray much lighter textured material that rests on partly consolidated sediments at a depth ranging from 30 to 40 inches. This soil is developed from weathered partly consolidated sediments, probably of marine origin.

The surface soil is moderately well supplied with organic matter and can be easily maintained in good tilth under cultivation. Unless cultivated, however, the surface soil loses moisture rapidly and tends to become hard and baked. The heavy-textured layer of the subsoil tends to retard subdrainage and gives up moisture slowly, and it remains moist throughout the greater part of the year.

Bodies of irregular occurrence and small extent are included with the soil as mapped, in which the heavy clay layer characteristic of the typical soil is lacking. The soil in such areas more closely resembles, in surface appearance, soil of the Diablo series, but it differs from the

Diablo soils in the absence of lime in the subsoil and in the high content of rounded quartz sand which does not occur to a great extent in soils of the Diablo series. In the vicinity of the adjoining Oceanside area on the south, the soil is of slightly heavier texture than typical, and it joins with Tierra loam of that area. In this survey, the areas of loam texture are included with Tierra sandy loam, owing to their small extent.

Tierra sandy loam is extensively developed near the headwaters of Cristianitos Canyon, a comparatively large body is in the northern part of the area surveyed, near the headwaters of Aliso Creek, several areas of different sizes border Las Pulgas and Piedra de Lumbre Canyons, and a number of small bodies occur throughout the hilly northern and central parts of the area.

About 10 percent of the land is under cultivation, and the rest supports a fair stand of grass or brush and is used as grazing land. Barley and beans are rotated over the cultivated parts of the land. Crop yields are in general lower than on the associated Diablo soils. This soil has low value for agriculture and under future development will probably prove best adapted to general farm crops.

Las Flores fine sandy loam.—Las Flores fine sandy loam has a light brownish-gray or dull brownish-gray surface soil from 8 to 12 inches thick. The subsoil to a depth ranging from 24 to 32 inches is distinctive, consisting of brownish-drab sandy clay that lies abruptly below the surface soil and continues uniform to a lower depth where it grades into pinkish-gray partly consolidated sediments. The underlying sediments, although partly consolidated, are permeable to moisture and of lighter texture than the overlying material. This soil represents soil material derived from weathered marine sediments. The heavy-textured layer is tough and plastic when wet, but on drying breaks into vertical 5 to 8 faced prisms, or columns, the tops of the columns being rounded. Considerable pressure is necessary to break the columns down to a finer structure. Both the surface and subsurface material are without refractory structure and may be broken down to a granular or small cloddy structure under cultural operations.

The soil is poor in organic matter and becomes hard and baked when dry if not cultivated. Subdrainage is restricted by the heavy sandy clay subsoil, and the soil is poorly adapted to any form of agricultural development under irrigation.

A variation is included in this soil as mapped, in which the soil is pale brown or pale pinkish brown. In profile it is very similar to the typical soil. Four bodies of this included soil occur in the area—one, a mile east of Fallbrook Junction and the others 2 miles northwest of Home Ranch. In the vicinity of the boundary between the Capistrano area and the Oceanside area on the south, the surface soil is somewhat lighter in texture and joins with Elkhorn loamy fine sand of the previous survey.

Typical bodies of Las Flores fine sandy loam occupy undulating or hilly areas throughout the southeastern part of the area. About 90 percent of this soil occurs in a number of bodies lying in a narrow belt extending northwest from Home Ranch as far as the headwaters of Arroyo San Onofre, and other bodies lie a short distance east and northeast of Home Ranch.

Less than 1 percent of the land is under cultivation, and the remainder supports a scant growth of grass. Cultivated areas are used only for barley or beans, and yields are generally poor. The soil has low value for agriculture and is subject to erosion.

Las Flores fine sandy loam, friable-subsoil phase.—A friable-subsoil phase of Las Flores fine sandy loam is differentiated in the surveyed area. The surface soil of this phase is similar to that of typical Las Flores fine sandy loam, but the subsoil consists of moderately compact loam or fine sandy loam, that rests on partly consolidated sediments at a depth ranging from 30 to 40 inches. Soil of this character more nearly resembles soils of the Arnold series as mapped in other areas in the State. Bodies of this soil occur 3 miles northwest and 1¼ miles east of Home Ranch.

About 50 percent of the land of this phase is under cultivation, and it returns fair yields of barley. It has somewhat higher agricultural value than the typical soil, though it is comparatively infertile. If well supplied with organic matter, under irrigation the soil could probably be utilized for vegetables, bulbs, grapes, or cane fruits.

Huerhuero fine sandy loam.—Huerhuero fine sandy loam is characterized by a pale yellowish-brown or light grayish-brown friable surface soil from 12 to 15 inches thick, which gives way abruptly to the upper subsoil layer consisting of dark-brown or chocolate-brown sandy clay that is of columnar structure when dry and of tough waxy consistence when wet. The tops of the columns are rounded. This material extends to a depth ranging from 30 to 40 inches where it is underlain, to a depth between 60 and 70 inches, by yellowish-brown sandy clay loam or fine sandy loam material that is mottled with gray lime-carbonate segregations. The lower subsoil layer to a depth of more than 6 feet is composed of pale yellowish-brown moderately compact loam or fine sandy loam without appreciable lime accumulation (pl. 1, B). This soil is of mixed origin and well weathered.

The surface soil in uncultivated areas is in most places hard and baked, though under cultivation it may be easily prepared into a mellow seed bed. The soil has a good water-holding capacity, though the heavy-textured subsoil gives up moisture slowly and crops frequently suffer from lack of moisture even though the subsoil may be moist.

A number of included areas have very gravelly surface soils and are shown on the soil map by gravel symbols. The gravel constitutes from 10 to 20 percent of the soil mass and under cultivation would interfere materially with cultural operations. The soil as mapped also includes a variation in which a partly cemented zone, or hardpan, occurs in the subsoil at a depth ranging from 30 to 40 inches. This hardpan layer interferes with subdrainage and root penetration, though the heavy layer directly above also interferes to about the same extent. Bodies of this character occur in the extreme southern part of the area bordering the ocean, just northwest of San Onofre, and on the west side of San Juan Valley in the vicinity of Dana Point.

Typical bodies of this soil occur at Dana Point and at numerous other places bordering the ocean. Bodies are mapped along practically all the larger streams of the area, particularly in San Juan Valley, Arroyo San Mateo, Piedras de Lumbre Canyon, and Arroyo Trabuco.

Not more than 1 percent of the land is under cultivation, and the rest, which is open and grass covered, is used for grazing land. Most

of the cultivated acreage is used in the production of barley, and smaller acreages are devoted to fruit or truck crops. On account of poor subdrainage this soil is poorly adapted to irrigation, although with careful use of water it can be utilized in the production of shallow-rooted crops, such as vegetables, bulbs, grain, and vine and cane fruits.

Stockpen fine sandy loam.—The 10 to 14 inch surface soil of Stockpen fine sandy loam consists of light-gray or dull-gray material which changes abruptly to dull-gray or grayish-drab sandy clay or sandy clay loam, that is stiff and plastic when wet, and dries out into hard bricklike columns. This material extends to a depth ranging from 24 to 30 inches and gives way gradually to gray clay loam or sandy clay loam of cloddy structure, which contains numerous gray lime-carbonate segregations. The zone containing lime accumulations extends to a depth ranging from 46 to 54 inches and grades into gray fine sandy loam or loam, without noticeable lime accumulation, that continues uniform to an undetermined depth below 6 feet. This soil is well weathered and is developed largely on outwash material from soils of the Las Flores series.

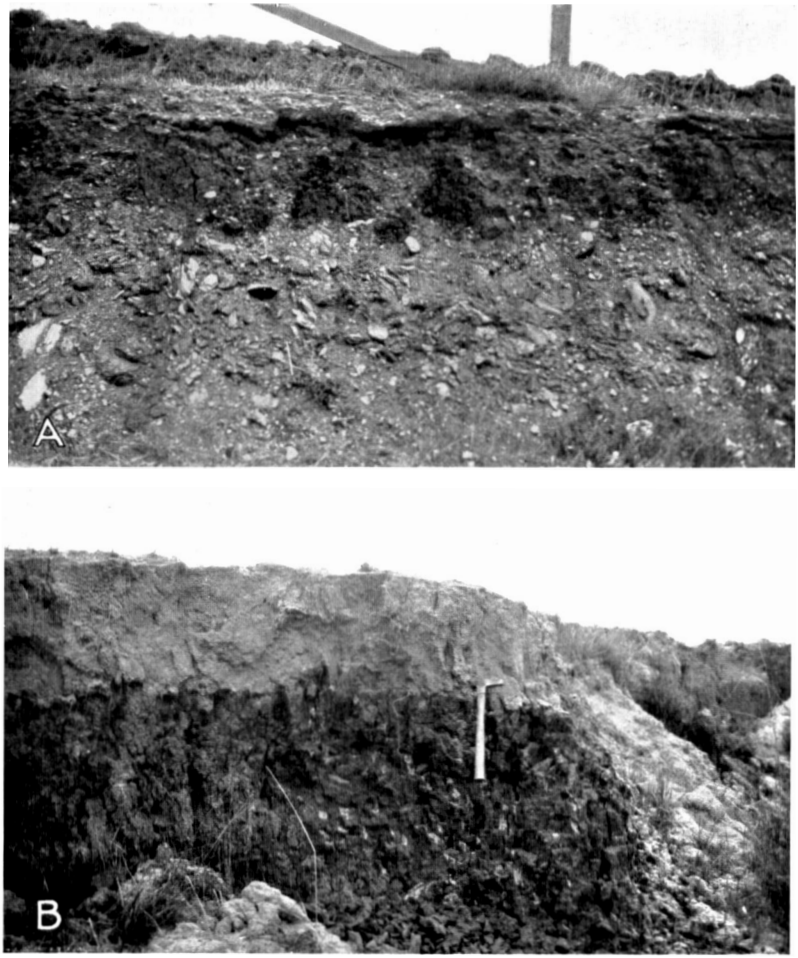
The surface soil is poor in organic matter, and under virgin conditions it is hard and baked when dry if not cultivated. The heavy-textured subsoil retards capillary movement of moisture, and crops soon suffer from lack of moisture during long hot periods.

This soil is developed on the coastal terraces at San Clemente, and small areas border Arroyo San Onofre. Several bodies occupy alluvial terraces in the vicinity of Stockpen on the Fallbrook branch of the railway.

Practically none of the land is under cultivation and it is not well adapted to cultural practices. Under virgin conditions it supports a fair stand of native grasses and is valued for grazing. It is poorly adapted to irrigation, as the heavy tight subsoil retards subdrainage and is unfavorable to root or air penetration. Shallow-rooted crops can be grown successfully under irrigation if care is exercised in handling the water.

Stockpen fine sandy loam, heavy-textured phase.—Included in the heavy-textured phase of Stockpen fine sandy loam are two rather distinct soils, both of clay loam texture. In one, the soil conforms in color and structure to typical Stockpen fine sandy loam, but the surface soil is deflocculated clay loam. The subsoil is tight and compact and has a lime accumulation similar to the typical soil. It occurs in only one small body bordering the coast one half mile south of the mouth of Las Pulgas Canyon. It is used for grazing.

The other soil consists of a dark-gray clay loam surface soil overlying a subsoil that is only slightly darker than that of typical Stockpen fine sandy loam. Bodies of this character occur in a number of localities in the area. Two small areas are in the vicinity of Don—one, a quarter mile west, and the other a mile northwest; a comparatively large area is in the canyon north of San Clemente; two other areas in this vicinity are 2 miles north and a mile southeast of San Onofre; two small bodies border the coast 2 miles northwest of Laguna Beach; and two others occur inland, one just west of San Juan Capistrano and the other bordering Arroyo San Mateo about 6 miles east of San Clemente.



A, Exposed soil profile of Konokti gravelly loam Note the parent material of broken schistose rock
B, Soil profile of Huerhuero fine sandy loam The subsoil begins at the point indicated by the head of the hammer

About 50 percent of the darker-colored soil of this phase is under cultivation. It has a moderate content of organic matter and produces fair crops of beans and grain. A few acres of this heavy-textured soil are used in the production of fruit. Under future development the soil should be adapted to the same crops and agricultural practices as is typical Stockpen fine sandy loam.

Aliso fine sandy loam.—Aliso fine sandy loam differs from the Stockpen and Huerhuero soils only in color. The surface soil to a depth ranging from 10 to 14 inches consists of pale-red, pale yellowish-red, or duller-red material that grades abruptly into dull-red or dull reddish-brown sandy clay of coarsely columnar structure. This heavy-textured material continues to a depth ranging from 22 to 30 inches, where it is underlain by pale reddish-brown or dull reddish-brown material containing appreciable lime-carbonate accumulations. This material, which continues to a depth ranging from 34 to 45 inches, is of somewhat lighter texture and of cloddy structure. The lower part of the subsoil to a depth of more than 72 inches is yellowish-brown fine sandy loam or loam. This soil is of mixed origin and is well weathered.

Although the soil has a high water-holding capacity, little benefit results as the clay subsoil gives up moisture too slowly to supply the needs of growing crops. The soil is easily cultivated and maintained in good tilth, but it is hard and baked under virgin conditions.

This soil as mapped includes some variations in texture, in which the soil is of slightly higher agricultural value Some small bodies are of very fine sandy loam or loam texture and would give slightly better yields under irrigation or dry-farm practices. One area of this character is one half mile north of Don, and several occur east of Santa Margarita River. Small gravelly bodies that have a somewhat lower agricultural value are also included. The gravel interferes with cultivation and tends to make the soil slightly more droughty than similar soils containing no gravel

The largest typical areas of this soil occur on the coastal terraces southeast of Las Flores Several small gravelly bodies border Las Pulgas Canyon. The soil is prominently developed at San Juan Hot Spring and bordering San Juan Canyon south of that place.

The heavy-textured compact subsoil renders this soil poorly adapted to irrigation or dry-farm practices, and at the present time none of the land is under cultivation With future development it should prove adapted to the same range of crops as are suited to Huerhuero fine sandy loam Blasting of clay subsoils that are not brittle or rocklike when wet is not recommended as they will run together as soon as wetted and no benefit will result. Tree roots penetrate the heavy-textured layer with difficulty and under irrigation there is always danger of drowning out or rotting the roots directly above the clay. The top of the clay layer is uneven and irrigation water will collect and stand in the lower spots for a long time, drowning out the roots at those points.

Merriam sandy loam.—To a depth ranging from 10 to 14 inches the surface soil of Merriam sandy loam consists of rich-brown or pale reddish-brown friable material which changes abruptly into dull reddish-brown or dull-brown tight compact sandy clay loam or sandy

clay of coarse columnar or cloddy structure when dry. The clay layer continues to a depth ranging from 26 to 32 inches and is underlain to a depth ranging from 44 to 50 inches by dull-brown or dull grayish-brown compact sandy clay loam which contains numerous lime carbonate segregations. The lower part of the subsoil, to a depth of more than 72 inches, is dull grayish-brown or dull-brown compact sandy loam or loam. The surface soil shows considerable granulation, owing to the penetration of innumerable grass roots and the stirring of the soil by burrowing animals or insects The subsoil is of columnar structure and breaks into coarse columns or clods that are extremely hard and partly cemented when dry. The zone of lime accumulation assumes a cloddy or roughly cubical structure when dry. The lower part of the subsoil, which is comparatively unweathered, is dense and without structural development. This soil represents well-weathered alluvial deposits derived from material washed out from granite rocks.

The surface soil contains considerable quartz grit and mica and it is friable and easily cultivated. The soil has good water-holding capacity and is somewhat better adapted to cultural and irrigation practices than other soils with heavy-textured tight subsoils mapped in the area surveyed.

A few small bodies of clay loam texture, comprising a total of less than 50 acres, are included in mapping. The soil of some areas is slightly browner than typical though not enough variation occurs to indicate significant differences in agricultural value.

This soil occurs largely on alluvial terraces bordering small drainage ways east of Santa Margarita River. Only one body lies west of the river, about 1½ miles northwest of Home Ranch.

About 40 acres of the land is used in the production of barley and the rest is grass covered and used as grazing land. If irrigated under future development the soil should prove adapted to small fruits and to some extent to citrus fruits

MISCELLANEOUS SOIL MATERIALS

Rough mountainous land.—Rough mountainous land consists mainly of comparatively inaccessible rough and mountainous areas that could not be economically covered in sufficient detail to map the small isolated bodies of agricultural soils known to be associated with this type of material. The agricultural areas comprise only a very small proportion of the total area of rough land and do not justify the time and expense necessary for mapping them in detail. Rough mountainous land covers a total area of 102 3 square miles in the area surveyed and most of it is in the Santa Margarita Mountains. The undifferentiated soils are mainly those of the Fallbrook, Vista, and Konokti series. Most of the land is brush covered, with oaks occupying the areas of higher moisture supply. The land is valued only for the small amount of grazing it affords in local areas

As mapped, this rough land includes areas of shallow stony soils, with frequent outcrops of bedrock, which occur in association with agricultural soils in the more accessible and developed agricultural districts, particularly in the eastern part of the area bordering Santa Margarita River. Granite or, in a few places, basic schist rocks outcrop over extensive bodies of this land.

Rough broken land.—Rough broken land consists of areas of such steep and eroded or broken relief as to be of no agricultural value. As mapped it includes some undifferentiated bodies of soil that represent a steep phase of Diablo clay adobe. Such areas consist of smooth slopes, too steep to be cultivated, which are grass covered and valued for grazing. This class of miscellaneous material is in general, however, badly eroded and broken up, and it is covered with chamiso and other low-growing brush. It is extensively developed in the northeastern part of the area.

Tidal marsh.—Tidal marsh consists of saline sedimentary deposits that are inundated at periodic intervals by the tides or lie but little above normal tide level. Such areas are poorly drained even at low tide and are too saline even if protected from tidal waters to be of value for agriculture. Tidal marsh occurs only in the coast region and occupies low flat stream-delta areas, most of them near the mouths of the more important drainage ways.

The surface soil is dull brownish-gray or dark grayish-brown material which is variable but fine in texture. It is underlain by dull brownish-gray or grayish-drab stratified material of similar or somewhat heavier texture than the surface soil. In general, yellow, gray, and rust-brown mottlings occur in the surface soil and subsoil. Lime is present in the subsoil though not everywhere in the surface soil

Tidal marsh is covered with pickleweed and other salt-resistant vegetation of little or no value for grazing

Coastal beach and dune sand.—Coastal beach and dune sand borders the ocean and consists of loose white beach sand that is subject to attrition of the waves during high tide and the influence of sun and wind when exposed at low tide. It supports no vegetal growth and is valueless for agriculture

River wash.—River wash occupies the channels of many of the larger streams of the area. In general, it consists of poorly assorted sands, gravel, and cobbles, that are subject to overflow with each succeeding period of high water. In some localities salt grass and other grasses carpet the material during dry periods and afford good grazing. Most of the land is barren, however, except for a few willow trees or wild tobacco plants that have obtained a foothold in protected places. It has no value except for the grazing it affords during the low-water stages of the streams in the channel of which it occurs.

ALKALI

In the Capistrano area soils affected with alkali are shown on the soil map enclosed in broken red lines with the symbol A in red on the area affected A dot indicates the spot at which the sample was taken and the average concentration of total salts to a depth of 6 feet is expressed in terms of percentage of salts in the air-dry soil.

Soil having less than 0.2 percent of alkali salts are considered free from injurious accumulations as regards crop production. As a general rule soils with 1 percent of salts cannot be profitably farmed unless the alkali can be held in the lower part of the subsoil away from the feeding zone of plant roots. If drainage conditions are poor and the alkali is concentrated in the surface soil, concentrations of 0.2 percent will frequently prove prohibitive to profitable crop production.

The alkali problem in the Capristano area is not serious, as only a few small bodies having injurious salt accumulation occur Bordering the coast, soils of the tidal marsh areas have a considerable accumulation of sodium chloride, ranging as high as 3 percent. Such bodies are unsuited to any form of crop production, and they cannot be reclaimed, owing to their proximity to the ocean and the presence of a high water table that fluctuates with the tides. Areas of Foster very fine sandy loam in Santa Margarita Valley contain different concentrations of alkali Some of the lower-lying bodies of this soil have a high water table and comparatively high concentrations of alkali, rendering the soils unfit for crop production. A few scattered areas of alkali accumulation occur elsewhere in the poorly drained localities. A few areas, too small to be differentiated on the map, occur in Las Pulgas Canyon, Piedra de Lumbre Canyon, and in San Juan Valley.

Alkali lands cannot be reclaimed unless they have good drainage. After drainage has been established, flooding the soils and turning under organic matter will aid materially in their reclamation.

IRRIGATION

Many of the more specialized crops cannot be grown in the Capistrano area without irrigation Beans and the small-grain crops are grown at present under dry-farm practices and fair yields are obtained in good seasons. However, in seasons of low rainfall, crop failures are not uncommon.

About 4,000 acres in the area are under irrigation and about half of the irrigated land is served by gravity water The old San Juan Capistrano Mission ditch is used to irrigate the lands in the lower part of San Juan Valley. During the last part of the growing season pumped water supplements that carried by the ditch Irrigated lands in San Onofre and San Mateo Valleys are served by pumped water About half the irrigated land in Santa Margarita Valley obtains water by gravity and the other half depends entirely on pumped water

Alfalfa, truck, walnuts, citrus fruits, and other fruits are produced under irrigation. Beans grown under irrigation produce an average of about twice as much as those grown under dry-farm practices. Alfalfa is irrigated by flooding and other crops are all irrigated by the furrow method.

Under future development, with irrigation, practically all the soils of the area having favorable surface relief and good drainage can be successfully irrigated where the water supply is sufficient. Those soils having heavy clay subsoils that retard subdrainage must be handled very carefully under irrigation to prevent excess moisture accumulating over the clay and causing the lower plant roots to be drowned out. On such soils an overhead system of irrigation would give the most satisfactory results, but it depends on the crops to be grown whether or not such an expensive system would be profitable

For vegetable and other shallow-rooted crops, as well as for young orchards, 18 inches of water a season will generally be sufficient. Alfalfa and old orchards will require much more, generally about double that amount. Bordering the coast, where the humidity is higher and the days cooler, less water will be required than farther inland, where climatic conditions are not so favorable.

SOILS AND THEIR INTERPRETATION

The Capistrano area lies in the southern California coastal region, a region characterized by cool moist winters and warm dry summers, where climatic and other weathering influences have produced soils largely of different shades of brown. The soils are never frozen, though alternate wetting and drying have a comparable influence in limiting bacterial activity and in producing alternate shrinking and swelling of the soil. During the wet winter season the soils are moist to a depth ranging from 6 to more than 8 feet. The rains cease in April, and in a few weeks the surface soils are dry and the grasses become parched and brown. No rain falls during the rest of the summer, and it is not long before the soils are completely devoid of apparent moisture, and shrinking and cracking takes place. Cracks 3 or 4 inches across occur in the clay soils, and they extend to a depth ranging from 5 to more than 6 feet before the rains commence late in the fall. The well-weathered soils with heavy clay and colloidal accumulation in the subsoil have well-defined joint or breakage planes, along which the soils crack on drying, though soils with sandy surface soils and lighter-textured subsoils show no cracks caused by shrinkage.

Virgin soil areas support a vigorous growth of native grasses, consisting principally of wild oats, foxtail, bur clover, and alfilaria. Willow and sycamore trees occupy the creek bottoms having a year-round underground water supply, and scattered oaks dot the hillsides protected from the afternoon sun. The trees increase in number on the slopes at higher elevations having a better moisture supply. Chamiso and other low-growing brush occupy the extremely gravelly or shallow eroded soils of the area. The oaks and brush contribute very little organic matter to the soils, and the hot dry summers thoroughly oxidize that contributed by the grass cover, except in areas that remain moist throughout the year.

Physiographically the Capistrano area may be divided into a coastal-plain section, a stream-terrace and alluvial-fan section, and a hilly and mountainous section, in all of which the condition or degree of weathering of many different rocks has contributed to numerous soil series.

The coastal plains are made up of soil material that has largely lost its inherited characteristics, owing to reworking by marine influences and later weathering agencies. The soils have a higher content of silica than other soils of the area and are composed of rounded soil particles that are less subject to disintegration under weathering influences and produce more compact and deflocculated soils. Not all the soils bordering the coast, however, have been subjected to marine influence, some having been derived from alluvial-fan or stream-terrace materials. The soils of this character have parent materials more or less mixed in character, depending upon the character of the rocks occurring in the drainage basin of the stream which they border. Differences in character and degree of weathering along with differences of parent materials have resulted in a great number of different soils. The hilly and mountainous areas, which are occupied by soils developed from residual materials and not yet fully weathered, partake more nearly of the mineral and chemical character of the rocks from which they are derived than do any other soils of the area. In these hilly or mountainous areas, soil creep and erosion are

generally more or less active and keep pace with disintegration of the underlying bedrock and weathering agencies. Where erosional influences are not active, soils of this character have well-developed B horizons.

Granite rocks occupy the greater part of the east-central part of the area and have contributed to greater or less extent to the formation of many of the soils of the area. Aside from the San Onofre Mountains, which are made up mostly of basic rocks that have contributed very little to the soils of the area, the underlying rocks are from sedimentary and granitic materials.

For the purpose of discussion in showing the relationship of one soil to another, the soils of the area, aside from a group of miscellaneous nonagricultural materials, have been placed in four groups, the group classification being based largely on differences in parent materials and the degree of weathering as expressed in the character of the surface soils and subsoils Group 1 is composed of the slightly weathered soils from residual materials; group 2, of the unweathered recent-alluvial soils; group 3, of the moderately weathered alluvial soils; and group 4, of the maturely weathered alluvial soils. The soils included in these four groups are those shown in their respective groups in table 2 on page 9.

The soils of group 1 have weathered in place from the consolidated country rocks of the region. The surface soils are loose and friable and range in color from pale red to black. Some have lime in the surface soil and subsoil, and others contain lime only in the subsoil or none at all. Those soils containing lime are darker colored than those without lime. The subsoils of the soils of this group are typically slightly more compact and heavier textured than the surface soils, though in none of them does a pronounced accumulation of clay or colloidal material occur.

The profile of Fallbrook sandy loam is typical of the profiles developed in the soils of this group. Under virgin conditions the surface inch or two, or A_1 horizon, consists of dull-brown or dull reddish-brown loamy sand containing a slight amount of partly decayed organic matter. This horizon contains a rather high proportion of angular quartz sand that gives to the surface a grayer cast on casual observation than is borne out by close examination. This material of single-grain structure grades into the A_2 horizon of dull reddish-brown or brownish-red sandy loam that is of firm consistence and breaks into clods that may be broken down under slight pressure to a granular or single-grain structure. At a depth of 10 or 12 inches a gradual transition begins and the soil becomes slightly more compact and heavier textured. This represents the upper zone of accumulation, or B_1 horizon. To a depth ranging from 26 to 34 inches the B_2 horizon is dull brownish-red or dull-red heavy sandy loam, loam, or sandy clay loam. In this horizon there is a slight tendency toward the development of definite vertical lines of parting which, in older soils, result in the development of a prismatic or columnar structure. This material breaks into clods of irregular size and shape. The insides of cavities and the faces of partings are coated slightly with sesquioxide or organic colloids that are duller red than the soil beneath. When moist the colloidal deposition gives a glazed appearance to the surfaces of partings, but on drying it is not noticeable.

This horizon grades into a C_1 horizon, in which the material is brighter colored and of slightly lighter texture, consisting of rich reddish-brown or brownish-red loam or sandy clay loam. The material in this horizon is slightly compact and without structural development or evidence of colloidal accumulation. Above the point where it grades into granite bedrock, at a depth ranging from 36 to 45 inches, it becomes pale red or pale yellowish red and consists of coarse sandy loam containing different-sized particles of the parent rock.

The organic matter in the A_1 horizon is gray or brown when dry, depending on the degree of oxidation. This horizon is illustrative of the mechanics of the leaching processes. The topmost layer of the surface soil is composed of the coarser material, with little admixture of finer soil separates, the finer separates discernible to the eye increasing in quantity to a depth of 3 or 4 inches. When dry the A_2 horizon is firm, though, owing to the penetration of innumerable roots, insects, worms, and burrowing animals, it is permeated by channels and pore spaces that give to the soil its granular structure when broken down under slight pressure. The amount of pore space in the B_1 horizon is comparable to that in the layers above but, owing to the presence of clay and colloidal material, it is not reduced to a granular structure so easily as is the material above but breaks into fine or medium clods. In the B_2 horizon, the pore space is considerably less than in the overlying material and it is resistant to breakage, assuming naturally a coarse cloddy structure. The upper part of the C horizon is comparatively dense and amorphous, changing gradually to a single-grain structure overlying bedrock. This soil has only recently been recognized as representing a distinct soil series, and in the earlier reconnaissance survey of the San Diego region it was included in the related Sierra series.

The Vista soils have dull-brown or brown surface soils and have the same sequence of horizons as the Fallbrook soils. The B horizon is dull reddish-brown material of only slightly heavier texture than the surface soil. Only slight evidence of clay or colloidal accumulation is apparent, and the material assumes naturally a small or medium cloddy structure. The C horizon is similar to that of the Fallbrook soils except that it is of duller-brown color. These soils represent a younger, less well oxidized development of the Fallbrook soils. They were formerly included with the related Holland soils.

The Escondido soils differ from the Fallbrook soils in a number of respects, chiefly in the absence of any development of a B horizon. The surface soils and subsoils are of pale brownish-red color, and the soils are derived from basic schists. Though the surface inch or two of soil is slightly browner than the rest, the profile is without other distinguishing features aside from a single-grain or granular structure throughout. These soils have only recently been recognized as representing a distinct soil series. They were included with the Holland series, now recognized as Vista, in the reconnaissance survey.

The Carlsbad soils are developed on soil material which was at one time probably a marine beach. The surface soils and subsoils are composed of pale-brown, pale yellowish-brown, or pale reddish-brown material containing an appreciable quantity of rounded quartz sand. Under virgin conditions the surface soils are slightly baked or cemented when dry and have different quantities of rounded iron

concretions, slightly larger than a pea, scattered over the surface. The subsoils are slightly compact, but they contain no noticeable accumulation of colloids or clay. The upper part of the C horizon contains a comparatively large number of iron concretions above the point where it grades into bedrock of softly consolidated sandy materials mottled with gray and rust brown. The upper part of the parent material is more firmly consolidated than that beneath though considerable cementation occurs in vertical cracks that permeate the material. The surface soil reacts slightly acid to Soiltex, and the insides of root cavities are slightly grayer than the surrounding material. In the earlier reconnaissance survey these soils were included mainly with soils recognized at that time as belonging to the Kimball series.

The soils of the Altamont series are brown, pale brown, or pale yellowish brown in the surface soils and brown or rich brown in the subsoils. Overlying bedrock, they are decidedly yellow in color. The same sequence of horizons occurs in the soils of this series as in the Fallbrook soils, and structurally and texturally they are comparable The Altamont soils, however, are derived from weathered shales and sandstones, and lime carbonate occurs intermittently in the C_1 horizon.

The soils of the Diablo and Linne series are very similar, both having dark-colored surface soils and subsoils The Linne soils grade slightly to dark brownish gray in color and differ from the Diablo soils also in having lime in the surface soils and subsoils, whereas lime occurs only in the subsoils of the Diablo soils. However, the two soils intergrade, and small areas of the Linne soils join with the Diablo soils of the adjoining Anaheim area. In color and profile the Diablo soils resemble the Montezuma soils and to some extent they were included with Montezuma soils in the reconnaissance survey. The same sequence of horizons occurs in these soils as in the Fallbrook soils, and in the Diablo soils they are developed to about the same extent structurally and texturally. In the Linne soils, however, the B horizon, although noticeably more compact than the surface soil and of medium-cloddy structure, may be reduced to a granular structure under moderate pressure.

The soils of the Ysidora series have a somewhat variable profile that would warrant separation into two series if it were practicable to do so. The surface is marked by alternate mounds and depressions, each covering less than 2 or 3 square rods. The B horizon under the mounds is generally only slightly heavier textured than the surface soil, though in some places it is nearly as heavy as that occurring in the depressions, where the B horizon consists of very much heavier textured material than the surface soil. In the depressions, the subsoil assumes a columnar or coarse cloddy structure, but under the mounds it is dense and compact, without structural development. The surface soils are dull brown or dull reddish brown and the subsoils are of the same or slightly redder color. The soils are derived from weathering of a conglomeratelike material. They were not differentiated in the earlier reconnaissance mapping.

The surface soils of the Konokti soils are brown or dull reddish brown to a depth of 1 or 2 inches and they contain slight quantities of organic material. This horizon of granular structure grades into the A_2 horizon consisting of dull reddish-brown slightly heavier mate-

rial of small cloddy structure. The B horizon is red or dull reddish-brown material which is noticeably heavier in texture than the surface soil It is of the same structural character as the B horizon of the Fallbrook soils and contains about the same relative clay and colloidal accumulations. In many places the heavy-textured subsoil rests directly on bedrock of basic schists (pl. 1, A), though in general a poorly developed pale reddish-brown C_1 horizon of granular structure intervenes between it and bedrock.

Group 2 is composed of soil materials differentiated into series on the basis of color, lime content, and inherited mineralogical character. These soils are unweathered stratified alluvial deposits subject to overflow by the bordering streams.

The Hanford soils are brown or dull-brown micaceous soils derived from granitic rocks. Some of the Hanford soils were included with the Yolo soils of the reconnaissance survey

The soils of the Cajon series are of similar origin as the Hanford soils, but they are light brownish gray or dull brownish gray and are slightly calcareous in the surface soil and subsoil.

The soils of the Foster series have dull grayish-brown surface soils and very calcareous subsoils. They are derived largely from granitic rocks and contain large quantities of mica.

The Laguna soils have dull-gray surface soils and subsoils and they are derived from sedimentary rocks. These soils are noncalcareous.

The soils of group 3 have weathered to the same extent or only slightly more than those of group 1. They have developed on young or moderately old alluvial deposits and occupy alluvial fans and terraces underlain by the country rocks at a considerable depth below 6 feet.

The profile of Ramona sandy loam is typical of the soils of this group. Under virgin conditions the A_1 horizon to a depth of 1 or 2 inches consists of dull-brown deflocculated sand or loamy sand containing partly oxidized plant residue. The A_2 horizon to a depth of 10 or 12 inches consists of brown, grayish-brown, or somewhat richer brown firm sandy loam that is hard and baked when dry but may be crumbled to a granular structure under slight pressure. The granulation of the material in this horizon is effected in large measure by the action of plant roots and reworking by insects and worms The upper part of the horizon is more compact than the lower part, owing, no doubt, to trampling by livestock when the ground is wet. A gradual transition occurs between the lower part of the surface soil and the upper part of the B_1 horizon in which the material consists of moderately compact heavy sandy loam or sandy clay loam. In this horizon are a great number of root cavities that persist from season to season until finally filled with material carried from the upper layers by percolating water. The material is of cloddy structure but may be reduced to a medium-granular structure under slight pressure. A very gradual transition occurs between this horizon and the B_2 horizon, in most places beginning at a depth ranging from 22 to 26 inches and continuing to a depth ranging from 45 to 50 inches. This horizon is composed of compact light reddish-brown or pale brownish-red loam or sandy clay loam in which a slight colloidal glazing occurs on the faces of cracks and cavities. The glazing is of dull-red color and consists of a superficial coating of organic and sesquioxide colloids. A partly developed columnar structure occurs in this

horizon This gives way in the lower part to a coarse cubical or cloddy structure that is also imperfectly developed Clods broken from this horizon require considerable pressure to reduce to a smaller cloddy structure. Root and worm cavities are very numerous and they contain more or less granular soil material as well as organic remains. The upper part of the parent material, or C_1 horizon, consists of moderately compact pale reddish-brown or yellowish-brown sandy loam which is without structure but contains more or less pore space. It may be reduced to a granular structure under moderate pressure. The soil is immature but contains appreciable clay and colloidal material, accumulated through a period of weathering. This soil is of granitic origin. Some undifferentiated areas of this soil were included with the Las Flores and Kimball soils of the reconnaissance survey.

The surface soils of members of the Farwell series are dull grayish brown or dark brown. The upper part of the subsoil is of about the same color as the surface soil, though the lower part is light brown or dull reddish brown and mildly calcareous. The same sequence of horizons occurs in soils of this series as in the Ramona soils and the different layers show about the same degree of accumulation and compaction. These soils are derived from weathered basic rock material

The soils of the Elkhorn series are developed on the coastal plain, and they contain an appreciable quantity of rounded quartz sand. The surface soils are grayish brown, dull grayish brown, or somewhat richer brown and, though firm, break to a granular structure under slight pressure. The subsoil is amorphous material of pale reddish-brown color. Though very compact and partly cemented when dry the material is comparatively friable when moist. The lower part of the subsoil is less compact than the overlying material and it is yellowish brown in color. Textural horizons are indistinct, though subsoil compaction is very noticeable, especially when the soils are dry.

The Salinas soils are characterized by dull grayish-brown surface soils of granular structure. The upper part of the subsoil, or B_1 horizon, is imperfectly developed, consisting of slightly compact material of about the same color and texture as the surface soil. The lower part of the subsoil, or B_2 horizon, is slightly lighter colored and of similar or slightly heavier texture than the surface soil and is of cloddy structure It contains innumerable root channels and insect and rodent burrows. The material is mildly calcareous, with a slight tendency toward lime accumulation in the smaller root cavities. The parent material is light brown or light grayish brown, amorphous, and moderately calcareous This series of soils had not been recognized at the time of the reconnaissance survey and these soils were included in part with the Yolo soils of that survey and in part with the Montezuma soils which they somewhat resemble in color and upper subsoil layers.

The Botella soils are similar in all respects to the Salinas soils except that no lime occurs in any part of the profile of the soils grouped in the Botella series. They were included with the Yolo soils in the preceding reconnaissance survey.

The soils of the Clear Lake series are of about the same age and degree of weathering as those of the Salinas series. The Clear Lake

soils, in contrast to the Salinas soils, have dark-gray or black surface soils and upper subsoil layers. The lower subsoil layer is dull brownish gray and very highly calcareous. The soils of this series have weathered under conditions of poor subdrainage.

The soils of the Montezuma series are somewhat more mature than the Clear Lake soils, and the lime in the lower part of the B horizon is accumulated in seams or nodules. The color profile is similar to that of the Clear Lake soils, though structurally the soils differ to a considerable extent. The upper part of the B horizon is, in general, of imperfectly developed columnar structure, whereas the lower part of this horizon, in the zone of lime accumulation, has a fairly well developed cubical structure in typically developed areas. As developed in this area the Montezuma soils represent a somewhat less mature profile than typical, in which the lime is mainly accumulated lime rather than parent lime.

The surface soils of members of the Commatti series are dull gray or dull brownish gray. The B horizon is dull-gray material of slightly heavier texture than the surface soil. It is mildly calcareous and of cloddy structure that breaks readily to a granular structure. The parent material is gray or dull-gray amorphous material of about the same texture as the surface soil and generally very calcareous. These soils represent a moderately weathered profile development.

The soils of group 4 include maturely weathered alluvial-fan or stream-terrace deposits, also soils that have weathered in place from the underlying cemented or partly consolidated rock formations. A number of soils are mapped in this group, which differ one from another in regard to lime content, color, and in substratum or parent materials. In age or degree of weathering, as expressed in the soil profile, they are very similar. A light-textured surface horizon, that is slightly acid in reaction, is underlain abruptly by tight plastic clay or sandy clay which grades into the parent material The surface horizon consists of two or more layers as does also the subsoil, or B horizon. Wherever lime is present in the soils of this group, it occurs as a nodular or seamy deposition in the lower part of the B horizon, just above the point where this layer grades into the parent material. The soils of this group are referred to in Russian literature[8] as solonetz.

A typical profile of soils of this group is that of Huerhuero fine sandy loam. Under virgin conditions the topmost 1½ inches, or A_1 horizon, consists of deflocculated light brownish-gray fine sandy loam or loamy fine sand containing an appreciable amount of partly decayed organic matter. The organic material is in the process of oxidization and little or no humus is apparent in the surface soil. The lower part of the surface soil, horizon A_2, to a depth ranging from 12 to 15 inches is pale yellowish-brown or light grayish-brown fine sandy loam that is of firm structure until disturbed, when it breaks up granular under slight pressure. The material contains innumerable cavities or small threadlike channels that are slightly coated in the upper part of the horizon with dark-brown organic stains. Granular particles of soil partly fill the larger cavities, and organic material in various stages of decay is present in the smaller

[8] NEUSTRUEV, S. S. [AN ATTEMPT IN CLASSIFYING SOIL-FORMING PROCESSES IN RELATION TO THE GENESIS OF SOILS] 46 p., illus. Leningrad. 1926. [Original in Russian]

threadlike channels. A distinguishing feature of the soils of this group is the abrupt transition from the lower part of the A_2 horizon to the upper part of the B_1 horizon. Within less than one half inch the surface soil of fine sandy loam texture changes to tight waxy sandy clay that on drying assumes a columnar or prismatic structure (pl 1, B). The columns are from 2 to 4 inches in diameter and have from 5 to 8 faces. When dry there is generally a small air space intervening between the lower part of the surface horizon and the upper part of the clay layer. The tops of the columns are somewhat rounded, the angle of slope increasing sharply near the edges of the columns. A gray deposit from one third to three eighths inch thick overlies the tops of the columns. This deposit is of platy structure in the upper part but is firm and slightly speckled with rust brown in the lower part When disturbed the upper part of the gray deposit is of floury structure and the lower part is brittle and breaks up granular The upper inch or two of the columns is of a very dark brown or chocolate-brown color which changes gradually with depth to a dull-brown or dark yellowish-brown color at their base. Root cavities are fairly numerous in the columnar material and are coated with dull-brown or dark-brown colloidal material as are also the faces of the columns. The columnar B_1 horizon grades into the B_2 horizon at an average depth of about 32 inches. This B_2 horizon extends to a depth ranging from 60 to 70 inches and consists of dull yellowish-brown fine sandy loam or clay loam of cubical structure. Cuts exposed to the sun assume a regular pattern of cubes that are from 2 to 3 inches in diameter Gray lime-carbonate accumulations give exposed cuts a mottled appearance along a definite zone of this horizon, decreasing in number in the lower part. The soil material surrounding the nodules of lime is in most places noncalcareous, except in root channels immediately surrounding the nodules. Root channels are numerous in this horizon, and the insides of the channels as well as the faces of the cubes are coated with yellowish-brown colloidal material of glazed appearance when moist. The cubical structure is less pronounced in the lower part of the B_2 horizon as it grades into the C_1 horizon which consists of dense amorphous pale yellowish-brown loam or sandy loam. Small roots fill the cracks in this material, though no glazing caused by colloidal deposition is apparent. The soils of this series were included mainly with the Kimball soils in the earlier reconnaissance survey

The soils of the Aliso and Stockpen series have profiles identical with those of the Huerhuero soils except in color. The different horizons are developed to the same extent and are of the same depth and structure. The Aliso soils have pale-red or pale yellowish-red A horizons and dull-red or dull brownish-red B horizons. The parent material is yellowish brown. The A horizon of the Stockpen soils is gray or dull gray, and the B horizon consists of a dull-gray or grayish-drab clay upper layer and a gray layer of lime accumulation. The C_1 horizon is similar to the corresponding layer in the Huerhuero soils in texture and structure, but it is of gray color. These soils are derived from weathering of material outwashed from soils of the Las Flores series. They were not differentiated in the earlier reconnaissance mapping but were included with the Las Flores and Kimball soils.

The surface soils of members of the Las Flores series are light brownish-gray or dull-gray material, of single-grain or granular structure, having a slight organic accumulation over the surface. The lower part of the surface soil is firm, but it is extremely porous and breaks up readily to a granular structure. The A horizon in most places is not more than 10 inches thick, and it grades abruptly into the tight waxy sandy clay of the B horizon. This material is of columnar structure and has a characteristic gray deposit over the tops of the rounded or dome-shaped columns. The clay horizon extends to an average depth of about 26 inches, where it is underlain by gray or pinkish-gray mottled light-textured sediments that are partly consolidated. These soils differ from the Huerhuero soils in the absence of the layer of lime accumulation and in the character of the parent material.

The Tierra soils are similar to the Las Flores soils in profile development and in character of parent material but they differ from those soils in color. The surface soils are dull grayish brown or dark grayish brown and they contain moderate amounts of organic matter. The B horizon is dark-gray or grayish-drab sandy clay loam or sandy clay of columnar structure. The tops of the columns are rounded and have a slight development of gray material overlying them. Dark-brown or chocolate-brown colloidal material coats the faces of the columns and the insides of cavities. As in the Las Flores soils, the clay layer rests on partly consolidated dull brownish-gray sediments of light texture

The soils of the Merriam series are derived from weathering of material outwashed from granitic rocks. The surface soil consists of an A_1 and A_2 horizon of rich-brown or pale reddish-brown color. The topmost surface layer is of single-grain structure and slightly browner than the material of the underlying layer which is of granular structure. The B_1 horizon is dull reddish-brown or brownish-red material of sandy clay or clay texture and of columnar structure. The columns are rounded at the tops and have a gray floury deposit about one fourth inch thick overlying them. A dark reddish-brown or bronze colloidal deposition covers the faces of the columns and the insides of root cavities. The B_2 horizon has little apparent colloidal glazing and consists of dull-brown or dull grayish-brown compact material of somewhat lighter texture than the B_1 horizon. In the B_2 horizon, however, is a pronounced accumulation of lime carbonate, in which the lime is segregated into soft nodules in seams or cracks and in most places is coated slightly with colloidal material. The C_1 horizon is dull grayish-brown or brown amorphous material that is of about the same texture as the surface soil. It is compact but may be broken down to a granular structure. These soils are differentiated from the Huerhuero soils largely on the basis of color and character of mineral materials.

The results of mechanical analyses and moisture equivalent determinations of representative samples of soils discussed in the foregoing pages are given in table 4. The analyses were made by the division of soil technology, University of California. The results are of interest as interpretive of soil profile characteristics, particularly in connection with the development of the different degrees of illuviated horizons corresponding to stages in weathering and profile development.

TABLE 4.—*Mechanical analyses of several soils from the Capistrano area, California*

Soil type and sample no	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay[1]	Colloid[2]	Total clay	Moisture equivalent
	Inches	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Fallbrook sandy loam											
577624	0 to 11	9 1	13 2	7 8	28 5	17 6	12 4	4 6	6 7	11 3	19 7
577625	11 to 30	7 6	11 9	4 8	22 9	20 0	13 0	5 1	15 3	20 4	15 9
577626	30 to 40	6 1	6 9	9 4	22 7	22 4	13 3	6 3	13 7	20 0	17 7
Vista sandy loam											
577647	0 to 10	8 4	8.6	11 8	23 1	27 5	11 7	3 3	5 4	8 7	11 4
577648	10 to 36	6 2	6 6	7 7	25 4	31 0	11 6	4 1	7 7	11 8	11 7
577649	36 to 44	5 5	10 5	6 0	25 0	29 2	11 5	3 9	8 4	12 3	12 5
Escondido very fine sandy loam											
577645	0 to 15	2 5	4.2	4 1	7.7	49 3	23 2	3 8	5 4	9 2	14.4
577646	15 to 36	1 6	5 2	2 8	7 8	49 1	23 7	4 2	5 7	9 9	14 5
Carlsbad loamy fine sand											
577665	0 to 10	.4	6 4	28.4	34 5	14 7	8 6	3 1	3 6	6 7	6 4
577666	10 to 26	.7	11 9	16 2	42 8	12 8	8 1	3.6	3 7	7 3	6 4
Altamont clay											
577612	0 to 10	4	5	7	3 5	18 2	35 3	26 3	14 7	41 0	29 5
577613	10 to 36	2	6	4	8	20 3	35 1	24 7	17 7	42 4	29 4
Altamont fine sandy loam											
577614	0 to 10	2 3	6 5	5 8	24 4	22 7	18 2	7 3	13 0	20 3	18 8
577615	10 to 36	2.9	3 8	7.4	20 6	25 2	17 1	8.6	14 5	23 1	20 2
Diablo clay adobe											
577693	0 to 18	2	2	1	1 2	27 6	28 7	19 2	22 6	41 8	32 1
577694	18 to 30	.1	2	2	1 9	29.7	29 8	16 6	21 8	38 4	32 9
Ysidora gravelly sandy loam											
577663	0 to 9	11 8	8 7	8.7	29 0	19 0	14 3	4 0	4 3	8 3	18 3
577664	9 to 24	12 0	11 8	4 9	31 5	17 9	13 2	3 0	5 5	8 5	9 8
Foster very fine sandy loam.											
577643	0 to 10	.4	4 5	5 5	35 3	33 2	13 1	2 6	5 8	8 4	17 3
Laguna sandy loam											
577630	0 to 15	5 0	11 2	8 4	33 4	22 5	9 9	1 8	7 7	9 5	11 5
577631	15 to 45	5 3	7 2	9 4	18 3	19 8	19 0	7 4	13 6	21 0	19 6
577632	45 to 70	5 8	11 7	7 7	25 9	19 7	14 2	3 9	11 1	15 0	15 8
Salinas fine sandy loam											
577607	0 to 8	5	1 5	4 4	17 1	29 2	31 1	6 9	9 3	16 2	22 4
577608	8 to 22	1 7	3 6	4 1	24 9	35 5	17 9	4 1	9 2	13 3	28 4
577609	22 to 64	9	2 6	6 7	24 8	33 0	17 5	2 9	11 6	14 5	30 5
Botella loamy sand											
577604	0 to 10	13 1	15 1	17 2	21 6	16 9	7 8	2 4	6 1	8 5	9 3
577605	10 to 36	11 1	22 4	11 2	23 8	15 5	6 8	3 4	5 9	9 3	8 0
577606	36 to 72	11 7	16 9	17 1	20 8	16 1	7 4	3 4	6 7	10 1	9 3
Clear Lake sandy clay loam.											
577616	0 to 12	3 3	8 4	6 0	19 8	23 1	15 8	7 5	16 2	23 7	20 4
577617	12 to 45	3 8	5 5	9 3	16 6	19 7	18 7	9 8	16 8	26 6	24 7
577618	45 to 85	2 0	8 8	6 7	16 5	17 7	21 7	9 7	16 8	26 5	27 2
Elkhorn loamy sand											
577674	0 to 16	9 5	15 6	18 0	21 7	15 0	11 2	3 5	5 4	8 9	8 1
577675	16 to 50	9 4	20 1	10 8	25 2	14 4	10 2	3 2	6 4	9 6	7 5
577676	50 to 72	8 1	18 7	12 0	23 3	16.1	8 8	3 8	9 0	12 8	8 9
Farwell gravelly sandy loam											
577688	0 to 12	9 8	9 2	4 7	14 9	21 0	25 4	7.4	7 6	15 0	19 3
577689	12 to 50	8 3	10 0	5 3	18.5	17.7	24 1	6 4	9 6	16 0	17 4
577690	50 to 72	12.8	10 0	10 1	15 1	18.4	20 3	4 6	8 7	13 3	15 4
Ramona sandy loam											
577633	0 to 11	11 3	13 5	14 4	16 2	21 4	12 8	5 1	5 4	10 5	14 4
577634	11 to 48	13 2	13 9	6 6	12 3	16 9	9 8	5 7	22 0	27 7	16 2
577635	48 to 72	28 2	16 9	13 3	12.7	7 3	4 8	4 2	12 5	16 7	16 3
Montezuma clay adobe											
577601	0 to 30	4	1 4	.1	4 6	27 4	25 3	15 8	24 4	40 2	32 5
577602	30 to 40	7	1 0	1 6	6.5	32 7	20 8	9 0	27 7	36 7	32 9
577603	40 to 80	1 1	4.5	3 4	16 1	30 8	14 4	6 4	23 2	29 6	26 4
Commatti sandy loam											
577619	0 to 12	6 6	9 6	12 7	27 5	23 8	11 2	2 4	6 5	8 9	12 6
577620	12 to 50	1 8	5 0	4 8	25 3	31 7	17 7	4 6	9 0	13 6	18 1
577621	50 to 70	3 1	5 9	12 1	28 8	27 1	12 2	3 3	7 7	11 0	13 4
Tierra sandy loam											
577658	0 to 9	7 6	11 7	18 6	26 0	16 2	8 1	4 1	7 8	11 9	11 0
577659	9 to 28	7 5	15 9	9 6	20 8	12 2	8 0	8 5	17 5	26 0	17 4
577660	28 to 34	15 9	22 6	20 0	15 0	9 5	6 8	3 3	6 7	10 0	10 3

[1] Clay includes particles from 0 005 to 0 001 millimeter in diameter
[2] Colloid includes particles less than 0 001 millimeter in diameter

TABLE 4.—*Mechanical analyses of several soils from the Capistrano area, California*—Continued

Soil type and sample no	Depth	Fine gravel	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay	Colloid	Total clay	Moisture equivalent
Las Flores fine sandy loam											
577627	0 to 8	3 3	7 4	12 5	23 9	29 5	14 2	3 7	5 7	9 4	12 1
577628	8 to 26	1 8	5 7	4 5	13 3	20 6	11 7	7 6	36 3	43 9	30 7
577629	26 to 32	.4	1.8	21 7	41 9	13 6	8 5	------	------	12 7	31 4
Huerhuero fine sandy loam											
577667	0 to 12	2 0	7 9	6 6	29 1	25 2	18 0	5 2	6 0	11 2	13 7
577668	12 to 24	4	2 3	6 0	19 6	19 1	12.9	5 8	33 9	39 7	33 4
577669	24 to 35	4	3 6	4 8	28 1	21 6	11 2	3 6	26 5	30 1	30 6
577670	35 to 49	1 4	3 2	8 3	26 9	20 6	18.4	7 4	14 0	21 4	16 8
Alliso fine sandy loam											
577677	0 to 10	6 3	10 8	5 4	17 3	26 2	22 4	5 0	6 5	11 5	13 8
577678	10 to 23	2 6	4 0	5 7	9 6	16 0	16 8	23 4	21 9	45 3	37 2
577679	23 to 36	5 5	8 4	5 4	15 9	21 2	17 7	3 5	22 5	26 0	32.7
577680	36 to 72	2 7	4 2	3 6	24 1	30 6	13 8	2 5	18.6	21 1	22 0
Merriam sandy loam											
577650	0 to 12	6 8	13 4	7 3	20 2	25 9	16 0	4 4	6.0	10 4	12.4
577651	12 to 28	5 4	7 3	7 7	15 1	18 3	10 7	11 4	24 3	35 7	20 3
577652	28 to 48	6 6	10 9	5 7	21 6	24 4	10 3	5 4	15 5	20 9	17 7
577653	48 to 70	8 8	12 6	17 9	20 9	16 6	6 7	3 4	13 0	16 4	15 4

SUMMARY

The Capistrano area is in southern California, partly in San Diego County, and partly in Orange County. The Pacific Ocean borders it on the west. The area includes 418 square miles, or 267,520 acres.

The area embraces three dominant physiographic divisions as follows: An alluvial fan or terrace section borders the coast; this gives way on the east to rolling hills; and these, in turn, merge with rough mountainous areas farther east.

The coastal plains and rolling hill country are grass covered and the rougher areas are covered with chamiso and other low-growing brush. Willow, sycamore, and oak trees occupy areas having the better moisture supply.

Practically all the land of the area was granted to subjects of the Spanish Crown between 1837 and 1844.

The Atchison, Topeka & Santa Fe Railway affords railway transportation facilities to the area. A number of good highways traverse the area, but aside from the main highways public roads are few.

The climate of the Capistrano area is characterized by two contrasting seasons—a wet winter season and a dry summer season. The ocean has a moderating influence on the climate, so that neither exceptionally warm nor severe cold weather is ever experienced. The average annual rainfall near the coast is 12.85 inches, and the mean annual temperature is 61.4° F.

The agricultural development of the area is retarded by the large landholdings devoted to livestock raising The present agriculture consists mainly of the grazing of cattle and, to a less extent, of the production of fruit and truck crops on the irrigated bottom land, and of barley and beans under dry-farm practices on parts of the terrace and hill land.

About 15,000 acres in the area are under cultivation, of which about 4,000 acres are irrigated. An additional 130,000 acres are susceptible of cultivation under future development.

The soils of the area have been placed in four groups on the basis of differences in character of surface soil and subsoil, in stage of weathering, and in parent materials. The grouping is made on soil characteristics, but it is also an agricultural grouping, as each particular group is best adapted to certain crops and to certain agricultural practices.

The soils of group 1 have weathered in place from the underlying consolidated bedrocks of the region and do not have pronounced clay accumulations in the subsoils The soils of the Fallbrook, Vista, Escondido, Carlsbad, Altamont, Diablo, Linne, Ysidora, and Konokti series comprise this group. These soils, as a whole, are well adapted to the production of citrus and other fruit crops where the surface relief is favorable for irrigation and there is freedom from frost

The soils of group 2 have no profile development, and they consist of recently deposited stratified alluvial sediments, most of which are rather leachy and porous. The soils of the Hanford, Foster, Laguna, and Cajon series are mapped in this group. Walnuts and alfalfa are best adapted to these soils under irrigation, and citrus fruits also will do well on them if protected from frost.

The soils of group 3 embrace some of the best agricultural land of the area. These soils are developed on deep alluvial deposits and have moderate or slight clay accumulations in the subsoils. The soils of the Salinas, Botella, Clear Lake, Elkhorn, Farwell, Ramona, Montezuma, and Commatti series are in this group. These soils are well adapted to all crops grown in this region where frost conditions are favorable. The soils are absorptive and retentive of moisture and are readily penetrated by plant roots.

Group 4 includes soils having a pronounced clay accumulation in the subsoils. The soils of the Tierra, Las Flores, Huerhuero, Stockpen, Aliso, and Merriam series comprise this group. The heavy clay layer in these soils materially retards root development and limits the value of the land under irrigation.

Walnuts, citrus fruits, and truck crops, except those that can be grown during the winter season, are dependent on irrigation for their successful maturity. Barley and beans are grown without irrigation, though yields are much better if irrigation is provided. String beans, potatoes, and summer squash are produced without irrigation in comparatively frost-free belts during the winter.

Small bodies of soil in the area are affected with alkali. Such areas cannot be brought to maximum crop production unless reclaimed. Reclamation processes are dependent on good drainage.

○

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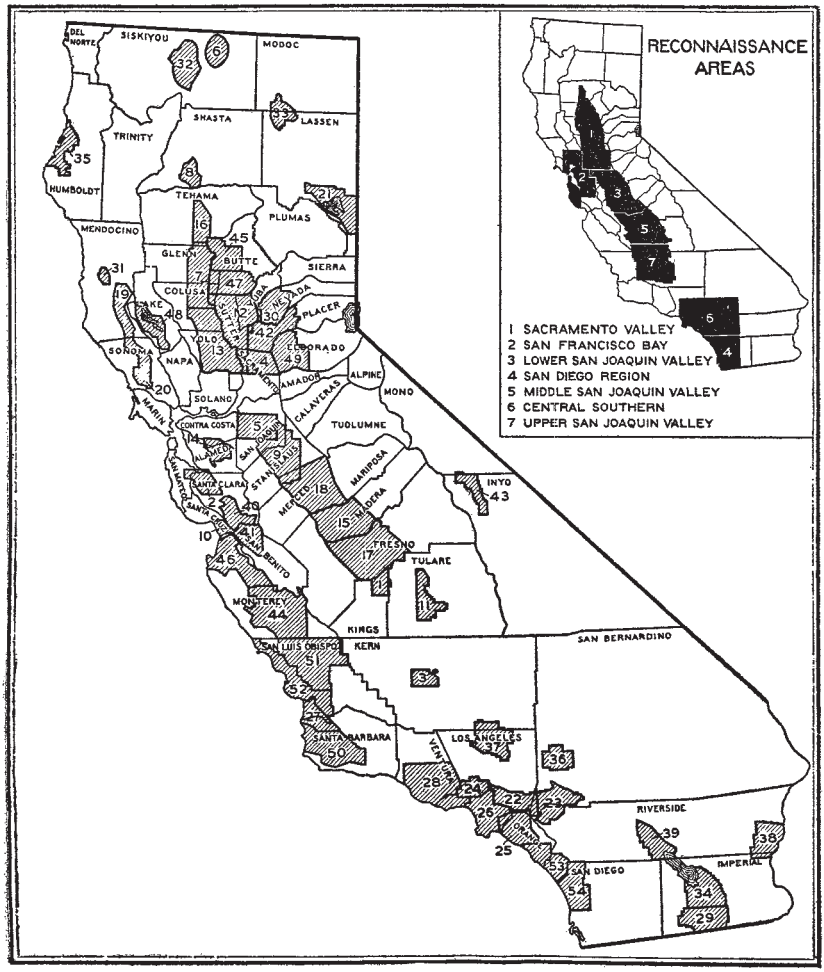

Areas surveyed in California, shown by shading

1. Hanford
2. San Jose
3. Bakersfield
4. Sacramento
5. Stockton
6. Butte Valley
7. Colusa
8. Redding
9. Modesto-Turlock
10. Pajaro Valley
11. Portersville
12. Marysville
13. Woodland
14. Livermore
15. Madera
16. Red Bluff
17. Fresno
18. Merced
19. Ukiah
20. Healdsburg
21. Honey Lake
22. Pasadena
23. Riverside
24. San Fernando
25. Anaheim
26. Los Angeles
27. Santa Maria
28. Ventura
29. El Centro
30. Grass Valley
31. Willits
32. Shasta Valley
33. Big Valley
34. Brawley
35. Eureka
36. Victorville
37. Lancaster
38. Palo Verde
39. Coachella Valley
40. Gilroy
41. Hollister
42. Auburn
43. Bishop
44. King City
45. Chico
56. Salinas
47. Oroville
48. Clear Lake
49. Placerville
50. Santa Ynez
51. Paso Robles
52. San Luis Obispo
53. Capistrano
54. Oceanside

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SOIL MAP

CAPISTRANO AREA
CALIFORNIA

UNIVERSITY OF CALIFORNIA
AGRICULTURAL EXPERIMENT STATION
E. D MERRILL, DIRECTOR
CHARLES F. SHAW, IN CHARGE SOIL SURVEY

CONVENTIONAL SIGNS

CULTURE (Printed in black)

- City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort
- Mine or Quarry, Mine dumps, Made land
- Bluff, Escarpment, Rock outcrop, and Triangulation station
- Secondary roads and Trails
- Railroads, Steam and Electric
- Stone and Gravelly areas
- Soil boundaries
- Bridges, Ferry
- R.R. crossings, Tunnel
- Boundary lines
- Boundary lines
- Ford, Dam
- School or Church, Cemeteries
- Boundary lines
- U.S. township and section lines

DRAINAGE (Printed in blue)

- Streams
- Lakes, Ponds, Intermittent lakes
- Intermittent streams
- Springs, Canals and Ditches, Flumes
- Swamp, Salt marshes
- Submerged marsh, Tidal flats

RELIEF (Printed in brown or black)

- Contours, Depression contours
- Prominent Hills, Mountain Peaks
- Sand Wash and Sand dunes
- Shore and Low water line, Sandbar

The above signs are in current use in the soil maps. Variations from this usage appear in some maps of earlier dates.

TYPICAL PROFILE DIAGRAMS

(6 feet deep)

Aliso fine sandy loam; Diablo clay adobe; Konokti gravelly loam; Salinas fine sandy loam
Altamont fine sandy loam; Elkhorn loamy sand; Laguna sandy loam; Stockpen fine sandy loam
Altamont clay; Escondido very fine sandy loam; Las Flores fine sandy loam; Tierra sandy loam
Botella loamy sand; Fallbrook sandy loam; Linne loam; Vista sandy loam
Cajon sand; Farwell gravelly sandy loam; Merriam sandy loam; Ysidora gravelly sandy loam
Carlsbad loamy fine sand; Foster very fine sandy loam; Montezuma clay adobe
Clear Lake sandy clay loam; Hanford sandy loam; Ramona sandy loam
Commatti sandy loam; Huerhuero fine sandy loam; Salinas sandy loam

LEGEND

(TEXTURE)

S	Sand
Ls	Loamy sand
Lfs	Loamy fine sand
Grsl	Gravelly sandy loam
Sl	Sandy loam
Fsl	Fine sandy loam
Vfsl	Very fine sandy loam
Grl	Gravelly loam
L	Loam
Scl	Sandy clay loam
Cl	Clay loam
Grc	Gravelly clay
Sc	Sandy clay
C	Clay
Cad	Clay adobe
Vse	Variably textured stratified sediments
Br	Bedrock

LEGEND

(STRUCTURE, ETC.)

Sycm	Slightly compact
Mocm	Moderately compact
Vycm	Very compact
Syca	Slightly calcareous
Moca	Moderately calcareous
Vyca	Very calcareous
Irca	Irregularly calcareous
Sycly	Slightly cloddy
Cly	Cloddy
Fr	Friable
Gra	Granular
Col	Columnar
Cu	Cubical
Lo	Loose
Mot	Mottled

LEGEND

Aliso fine sandy loam — As
Altamont fine sandy loam — Af
Altamont clay — Ac
Botella loamy sand — Bl
Heavy-textured phase — Bl
Cajon sand — Cd
Carlsbad loamy fine sand — Cl
Clear Lake sandy clay loam — Cs
Commatti sandy loam — Cm
Diablo clay adobe — Dy
Steep phase — Dy
Escondido very fine sandy loam — Ev
Fallbrook sandy loam — Fs
Friable-subsoil phase — Fs
Farwell gravelly sandy loam — Fg
Gray phase — Fg
Foster very fine sandy loam — Fv
Hanford sandy loam — Ha
Huerhuero fine sandy loam — Hs
Konokti gravelly loam — Kg
Elkhorn loamy sand — El
Laguna sandy loam — La
Las Flores fine sandy loam — Ly
Linne loam — Lm
Merriam sandy loam — Ms
Montezuma clay adobe — Ma
Rough broken land — Rb
Ramona sandy loam — Rl
Salinas sandy loam — Sm
Salinas fine sandy loam — Sa
Heavy-textured phase — Sa
Light-colored phase — Sa
Stockpen fine sandy loam — Sy
Heavy-textured phase — Sy
Tierra sandy loam — Ts
Rough mountainous land — Rm
Vista sandy loam — Vs
Ysidora gravelly sandy loam — Yg
Dark-colored phase — Yg
Coastal beach and Dune sand — Co
Tidal marsh — T
River wash — Rv
Alkali

Note: *Location of borings and result of field tests shown thus:* •.46 *The figure shows the average percentage concentration to a depth of six feet.*

Macy H. Lapham, Inspector, District 5.
Soils surveyed by E. J. Carpenter, U. S. Department of Agriculture, in charge, and R. Earl Stone, University of California.

BASE MAP IN PART FROM U. S. GEOLOGICAL SURVEY SHEETS

Scale 1/62500
1 0 1 2 3 Miles
1 0 1 2 3 Kilometers
Contour interval 25 feet.
Datum is mean sea level.

Field Operations
Bureau of Chemistry and Soils
1929